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S O M E
O B S E R V A T I O N S
R E L A T I V E T O T H E
I N F L U E N C E O F C L I M A T E
O N
V E G E T A B L E A N D A N I M A L B O D I E S.

By ALEXANDER WILSON, M. D.

Utque duæ dextra cœlum, totidemque sinistra
Parte secant zonæ; quinta est ædentior illis :
Sic onus inclusum numero distinxit eodem
Cura dei, totidemque plagæ tellure premuntur.
Quarum quæ media est, non est habitabilis æstu :
Nix tegit alta duas : totidem inter utramque locavit ;
Temperiemque dedit, mista cum frigore flamma.
OVIDII Metam. fab. ii.

L O N D O N :
PRINTED FOR T. CADELL, IN THE STRAND.
MDCCLXXX.



TO
WILLIAM CULLEN, M. D.

FIRST PHYSICIAN TO THE KING IN SCOTLAND,
AND PROFESSOR OF PHYSIC IN THE

UNIVERSITY OF EDINBURGH,

&c. &c. &c.

S I R,

TH E marks of attention conferred on me when your pupil, the intimacy you have honoured me with since that time, and a deep sense of the many acts of friendship I have received from you, all strongly impel me to take this opportunity of acknowledging these benefactions.

Motives of this kind, with a certain degree of pride, have induced me to address this short performance to you, Sir, whose character as a Philosopher, a Physician, and a Man, is not less admired by the votaries of science, than beloved by the friends of social virtue.

I am, with the greatest sincerity,

S I R,

Your most obedient and

Much obliged humble Servant,

ALEXANDER WILSON,

P R E F A C E.

IN perusing the following Observations, the Reader will readily perceive that most of them have been made in the warm climates; he will also see that the general scope of the whole is to shew the influence of climate on vegetable and animal bodies,

In the First Part I have endeavoured to prove, that a certain degree of the phlogistic principle is universally necessary to vegetation, and that the component parts of bodies are disengaged by putrefaction in a certain proportion to climate, which climate is always adequate to the re-application of the separated parts, to form new vegetables in the same proportion.

In the Second Part I have considered the human body as made up of vegetable matter, and possessing different powers and properties according to the greater or less affinity it bears to the vegetable kingdom.

I have also considered in what manner these different conditions of body are affected by different climates; and I have endeavoured to shew how the temperature and purity of the atmosphere may either promote or counteract the effects of food; to which are added, some opinions founded on the principles laid down, relative to the scurvy, consumption, and small-pox.

A putrescent tendency of body I have considered as a prevalence of the phlogistic principle. By this I do not mean to say, that the same body contains more phlogiston when in a putrid state, than when in a sound one. By putrescent tendency relative

tive to phlogiston my meaning is, that as all bodies are decomposed by putrefaction, and the phlogistic principle thereby separated from them, the same body will evolve this principle more copiously in proportion as the degree of its putrescent tendency is increased.

In the Third Part I have considered the effect of a putrescent state, in altering the external appearances of the human body, and changing or stupifying the powers of the mind. I have also endeavoured to shew how those effects result from both hot and cold climates; and from these principles I have drawn some conclusions relative to slavery and freedom in different countries; but as this leads to discussions foreign to my present plan, I have gone no further than what seemed to be necessary to shew, that the real state of facts corroborates the theory laid down.

I have endeavoured to comprise these Observations within narrow limits. It may perhaps be thought that brevity hath been too much studied ; but I flatter myself that an accurate attention to the connection which the different Chapters and Parts have with each other, will make my meaning distinctly perceived through the whole.

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E R R A T A.

- Page 4, line 13. Place the Comma at *inhaled*, and not at *pure*.
28, l. 17. For *chapter*, read *chapters*.
29, l. 3. For *alleged*, read *objected*.
55, l. 12. For *them*, read *it*.
65, l. 13. For *these bodies*, read *the sun and moon*.
127, l. 7. For *prevent* read *prevents*.
156, l. 7. For *poisons*, read *animal poisons*.
177, l. 3. For *are fitted*, read *are so much fitted*.
209, l. 16. For *its action to both*, read *its action both*.

P A R T I.

Of the Food and Circulation of Vegetables.

C H A P. I.

The Object of this First Part.

ON taking a general view of the earth, it will readily be allowed that vegetation in every part of it bears a certain general proportion to the Sun's influence, from which we are naturally led to consider him as the grand source of vegetable life; and although this conclusion must be admitted, yet to trace the manner of his action is a matter of enquiry. We mean,

B therefore,

therefore, in the following chapters, to attempt shewing that heat, by accelerating putrefaction, disengages the component principles of bodies from each other, and that by the joint action of the sun and moon these separated parts, or principles, are re-united, and differently combined in the various forms which compose the vegetable kingdom.

C H A P. II.

Air necessary to Vegetation.

NO plant will thrive *in vacuo*, and vegetables of all kinds receive from the atmosphere matters of such quality as are necessary for their vigorous growth, and by its assistance discharge their perspiration according to their different natures, and climates in which they are placed.

A plant kept in a dry and pure air soon becomes languid, though regularly watered at the root : this is a proof that pure water

and pure air, alone, will not promote a healthful and vigorous vegetation. The evident change which takes place in plants so circumstanced, after the fall of a warm refreshing shower, is full proof of their having got something besides moisture at the root.

Gardeners know that moistening the leaves, stems, and roots of plants with pump or river water will not answer, instead of natural rains, which in their descent through the atmosphere bring down some other ingredients necessary to vegetable increase.

C H A P. III.

Of the Ingredient in the Air necessary to Vegetation.

IT is a well-known fact, that air which hath been respired by animals is rendered unfit for the continued respiration of the

same, or any other animal, by being loaded with phlogiston. Dr. Priestley hath shewn, that when this air is deprived of its over-charge of this principle, it is again fit for respiration : his experiments, with those of Dr. Ingenhoufz, have also made it evident, that plants retain it as a proper and healthful food, which they absorb with the common atmospherical air, and that the action of vegetables, exposed to the light of the sun, fits that fluid again for the purposes of animal life, by discharging the impregnated air they inhaled, in a pure, de-phlogisticated state*.

The air which is detached from putrid vegetable and animal substances seems only improper for respiration by the quantity of phlogiston it contains; consequently as that which renders air noxious to animals makes

* See Ingenhoufz' Experiments on Vegetation, page 13.

it salutary to vegetables, we suppose it is this principle contained in natural rains which so much increases the growth of plants.

It is this phlogiston that gives a particular sulphureous smell, sometimes observable even in this country after long droughts in the heat of summer, which resembles the air of a room highly impregnated with electric matter. In the tropical latitudes this smell is often so strong as to become very disagreeable, particularly when the rains set in after a considerable duration of dry weather.

Phlogiston hath an affinity with water*, and also with the air contained in water, which promotes their union in the atmosphere, either in its descent, or when sup-

* See Priestley on air infected with animal respiration, vol. 1. p. 100.

ported in the form of vapour, which being condensed into rain, and falling on the stems and foliage of plants, is absorbed by them, and makes a principal ingredient in their composition : what escapes contact in this way sinks into the ground, and is probably taken up by the roots of the plant.

From this view it is evident, that differently impregnated atmospheres must affect vegetation very differently, and from this cause seems to arise the superior fertility of lands close to great towns, with less manure and labour than those of the same quality at a greater distance from such places of warmth and putrefaction, by which the dissolution of bodies is accomplished, and that phlogiston disengaged which impregnates the surrounding atmosphere.

The air of the Sugar Islands is so highly replete with this principle, that many plants
of

of quick growth, which have very few roots attaching them to the soil, are supported by it; the *no root*, a vine of rapid growth, has not the smallest hold of the soil, and a part of it cut and flung on any old wall, or tree, will vegetate vigorously, if in a warm and not over-dry situation.

C H A P. IV.

Probability that Phlogiston and Electric Matter are Modifications of the same Principle.

THE particular countries in which vegetation is most quick are the warmest, and most productive of putrefaction; where growth is less quick, putrefaction is in proportion slow; and we shall find that the quantities of lightning in different countries keep pace with the progress of putre-

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faction in them, the rapidity of which is in proportion to the warmth, when the surfaces of the countries are under equal circumstances.

Lightning is more abundant and frequent in Surinam, Isaac-cape, the Spanish main, and southern parts of America, than in countries equally woody in more northern latitudes, where the heats are less: these countries are famous for the rapidity of their vegetation, and the quick progress of putrefaction.

In the northern regions, about Groenland, there is scarce any lightning after summer*; although it is warm in the day, yet the cool evenings check the progress of putrefaction resulting from the sun's heat.

* The account of Mr. John Egede, a Danish missionary settled in Groenland fifteen years.—Harris's Collection of Voyages.

In Nova Zembla, still further north, thunder is scarce known. In the former of these countries there is a little vegetation, but it is confined to few plants, and that only for a very small part of the year; putrefaction is there in proportion flow. In the latter place vegetation is much less, and putrefaction in dead matter scarce proceeds at all in the open air,

In our own climate, when the weather is warm, close, and sultry, putrefaction goes on rapidly, and vegetation is vigorous in proportion. In such an impregnated state of the atmosphere lightning is most common while respiration becomes heavy and oppressed, in proportion to the phlogisticated state of the air.

The great quantities of lightning in hot countries seem to arise from the quick dissolution of bodies, by which the phlogistic principle

principle is disengaged. In the middle of the Atlantic ocean lightning is seldom seen; but as we approach the above-mentioned continents, it becomes more and more frequent. This a fact well known to seamen, which renders it further probable, that the same phlogiston which made a part in the composition of bodies, is lightning when disengaged from them. As an ingredient in the composition of plants, its quantities must not only keep pace with the decomposition, but also tend to promote vegetation in the same proportion*.

* Mr. Henly supposes fire, phlogiston, and electric matter, the same principle, differently modified. Mr. Cavallo considers fire and phlogiston the same, and points out some differences in the effects of fire and electricity; yet in conclusion he joins with Mr. Henly in thinking it highly probable that all the three are only modifications of the same principle.—Cavallo on Electricity, p. 115, 116, 117.

C H A P. V.

Of the Causes of Putrefaction.

HEAT hath generally been considered as the sole cause and promoter of putrefaction, and may therefore be called the grand septic principle of nature, as, without a certain proportion of it, none of the fermentations will proceed in any degree whatever.

Although heat is absolutely necessary to the progress of putrefaction, yet that process is exceedingly accelerated by phlogiston and lightning; and we shall find by the following experiments, that the contact of the lunar rays also very much promotes it.

About the latitude of 11 degrees north, in the month of February, a thin piece of
fresh

fresh beef, about four ounces weight, and perfectly sound, was cut in two equal parts, and kept in the same temperature from mid-day to seven o'clock in the evening ; one of the pieces was then covered with a box, which did not admit a particle of light ; the other was spread open, and exposed to a bright and full moon. They were both left in this state till next morning, at which time the covered piece shewed not the smallest sign of putrefaction, while the other smelt strongly. By two o'clock the same day the sound piece began to smell, but that which had been exposed to the lunar rays was much further advanced in putrefaction.

Facts of this kind are so generally known in those climates, that the fishermen, who are out all night, take care to prevent the rays of the moon from shining on the fish they catch ; yet notwithstanding their precautions, those taken in moon-light become

come putrid considerably sooner than others taken in the day-time, or when there is no moon-shine. For instance, two fish of the same kind, and nearly of the same size, were taken; one was killed about twelve o'clock in the day, and the other at seven o'clock in the evening; the first was put into a cellar from which the light was excluded, the last lay all night exposed to the full moon: at seven o'clock next morning both discovered signs of putrefaction, and by two o'clock the same day that which was first killed smelled strongly; while the other, which was killed seven hours after, and exposed to the moon-light, smelled as strong, and seemed more dissolved.

Innumerable instances of a similar nature to those we have mentioned might be adduced, to prove that the immediate contact of the lunar rays does actually induce putrefaction with remarkable rapidity; and
that

that this effect follows from the actual contact of the lunar rays, and not from the atmosphere, is undoubted, as no perceivable effects follow when the rays of the moon are excluded from contact with the animal matter.

We made various experiments to try if the contact of the lunar rays were productive of similar effects on dead vegetable substances, but the consequences were by no means remarkable. The slow progress of putrefaction in vegetable bodies, and the difficulty of keeping them in an equal state of moisture, made such experiments tedious and uncertain.

C H A P. VI.

Effects of Moon-light on growing Vegetables.

BETWEEN the tropics, it hath been long a general opinion among those concerned in the agriculture of those climates, that moon-shine, or the contact of the lunar rays, ripens fruits, and accelerates the growth of plants. To ascertain the truth of this opinion we made several experiments, and from the general result we are led to concur in its favour. As we found it impossible, without vast labour, to exclude the lunar rays from large vegetables, we confined our experiments to small ones.

About a dozen young cabbage plants grew together in the same bed ; six of them
 of

of equal vigour with the rest were covered up every night, soon after six o'clock, with a box which admitted no light, from six days after the change to six days after the full moon, and were uncovered every morning about, or soon after sun-rise, while the remaining plants were allowed a free exposure to the rays of the moon.

Those which were uncovered had evidently the advantage of the covered ones. The experiment was repeated with lettuces, and the advantage at the beginning was evidently in favour of those put under cover, by way of equivalent for want of the nocturnal humidity; yet notwithstanding, in two weeks, they were exceeded in size and beauty by those which stood exposed *.

* Even in this climate, the country people think that moon-light hath considerable influence in ripening the fruits of the earth.

This was a point rather too nice to be determined by the result of one or two experiments; we therefore concur in the general idea, from finding that every trial, and inquiry, tended more or less to prove the opinion founded on fact.

As putrefaction is undoubtedly accelerated in dead animal bodies by the contact of lunar rays, there is from that circumstance great reason to suppose it will forward the growth of plants, as every septic, we know, promotes vegetation, and every thing that promotes vegetation is more or less a septic when applied to dead vegetable or animal bodies. Dr. Ingenhousz has, by many curious and satisfactory experiments, proved that plants imbibe air in a phlogisticated condition, and discharge it in a very depurated state. This wonderful operation of plants on air he has shewn to depend on the action of light,

C independent

independent of heat, as in the same degrees of heat, without light, the vegetation of plants does not improve the quality of either noxious or atmospheric air. These facts give us reason to suppose, that this property of moon-light may be very considerable, as it is the solar rays brought to us by reflection, though in so rare a state as to be incapable of producing the smallest degree of heat by any concentration yet discovered.

C H A P. VII.

The Effect of Electric Matter in promoting the Growth of Vegetables, and the Putrefaction of Animal Substances.

THE Abbe Nollet has proved beyond a doubt, that electric matter, properly applied, accelerates the growth of vegetables;

bles; and, from what we have already mentioned, it is pretty clear that an atmosphere charged with lightning hath the same effect on vegetables, and also remarkably accelerates putrefaction in animal bodies.

In the middle of winter we divided a small fish into two equal parts along the back bone; the one half was kept in an electrified state for some hours each day, while the other lay exposed to the air in the same temperature: that which had been electrified emitted a putrid smell a considerable time before the other was affected. From this experiment it appears, that putrefaction is accelerated in animal substances by electric matter, and will in all probability be promoted in proportion to the quantity accumulated in it.

If therefore we admit phlogiston, lightning, and electric matter, to be the same principle, it will operate in inducing putrefaction where it exists naturally in bodies, as well as where communicated from without, either by an impregnated atmosphere or an electrical machine, under equal circumstances of heat and moisture.

The above facts tend still further to increase the probability that phlogiston and electric matter are the same; and we shall hereafter shew, that the putrescent tendency in animal matters is proportioned to the quantity of this principle in their composition.

C H A P. VIII.

Why Lightning is less frequent, and Growth less luxuriant in the West-India Sugar Islands, than on the Continents in the same Latitudes.

DR. Priestley hath proved, that contact and moderate agitation with water depurates phlogisticated air, and, like vegetation, renders it fit for the purposes of animal life *.

Small islands retain but small quantities of air, and the trade winds which blow continually over them are depurated by contact with the surface of a very extensive sea, by which they are enabled to unite with, and absorb the phlogiston disengaged from bodies on the land, and carry

* See Observations on Air infected with Animal Respiration.—Priestley, vol. i. p. 95.—and Ingenhousz, sect. 4.

a certain proportion of it from these islands: hence lightning is less frequent, and vegetation less luxuriant in them, than on continents in nearly equal latitudes.

The difference between small and large islands is also most evident; and even on the sea-coast of the same island vegetation is flower, and lightning less frequent, than in the more interior parts, where the air is less agitated and more impregnated, by being less exposed to the contact of the depurated sea air.

C H A P. IX.

A Conjecture why on the South of the Equator, in equal Degrees of Latitude, it is much colder than on the North.

IT hath been an observation generally made by voyagers to the south of the equator, that in the same degrees of latitude

tude the colds were considerably more severe, than on the northern hemisphere.

As the fact is undoubted, the following conjecture seems to afford a probable explanation of it.

The different quantities of phlogiston disengaged by putrefaction in any two extensive districts of the globe, equally situated as to latitude, depends on the quantity of land in each district, its height and regularity of surface, and the manner in which it is clothed with vegetables, and stocked with animal bodies; and in whichever the surfaces are most flat, and these productions most abundant, the air will there be most highly impregnated, or phlogisticated, and in proportion warm.

When we take a view of the southern and northern hemispheres of the earth,

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the land on the north is found equal to one half its whole surface, and the waters in many places are so interspersed with it, that they may be considered as narrow inlets, over which the impregnated land air passes without being so totally depurated as in wider seas. Even the most extended part of the northern ocean has many considerable islands scattered through it, from the surfaces of all which vegetable and animal bodies are continually suffering a decomposition by putrefaction.

To the south, is an immense extended sea, without any large bodies of land, except the capes of Good Hope and Horn, and the lands of New Zealand, New Holland, and New Guinea, all of which are not equal to more than one-fourth, or perhaps one-fifth part of the surface of the southern hemisphere. The first extends not far to the south, is mountainous, and

narrow at its extremity : the second of these capes is also very high land, and runs much further south, but draws towards a point at its extremity, which is barren.

These lands are situated at a vast distance from each other ; consequently the winds which are about them, and blow over them, are in a more depurated state than similar winds in equal latitudes on the north of the equator. New Zealand, New Holland, and New Guinea, are at too great a distance from the Capes of Good Hope and Horn to influence the temperature of the air about them. Secondly, the rays of the sun, which fall on water, give no heat to that water, unless they meet some opaque body, by which they are reflected or retained. The same rays, so converged by a concave, or convex lens, that the focal point falls within the body of the water, communicates no heat to it; but if an
opaque

opaque substance is introduced into the water, and the focal point made to fall on its surface, it will immediately be acted upon. Hence we may suppose a large proportion of the sun's rays are lost in the southern hemisphere, as all that are not reflected from the surface, but pass into the body of the ocean, must lose most of their power before they can be supposed to reach the bottom; whereas, in the northern hemisphere, the large proportion of land affords a vastly greater surface of opaque matter for the reflection of the rays of the sun.

If to these causes of cold we add that produced by evaporation from such extensive seas*, the fact will appear tolerably well accounted for.

* See Dr. Cullen on Cold by Evaporation.—Edinburgh Physical and Literary Essays.

Lightning in the southern hemisphere is found less frequent than in the northern, which circumstance renders the above solution still more probable.

C H A P. X.

Effect of great and quick Changes of Climate on Vegetables.

PLANTS which are natives of cold climates, when removed to the torrid zone, soon become sickly, probably from too phlogisticated an atmosphere, which supplies that principle too fast for their powers of assimilation; that supply, with an over-perspiration, and probably a want of vessels adapted to absorb with sufficient rapidity to support this great discharge, are the causes of their ill-health, which perspiration we shall hereafter observe is the cause, and not the consequence, of absorption.

Those

Those of hot climates, carried into northern countries, have all their fibres contracted, and pores shut up, by the cold, which disables them from discharging their perspiration; therefore absorption is prevented, and matter for vegetation being less abundant in such an atmosphere than in their native climate, they die from languid circulation and want of food. And we shall hereafter endeavour to shew, that the circulation of the vegetable kingdom keeps pace with the actual and natural supply of food resulting from climate.

C H A P. XI.

*Probability that without some Degree of
Phlogiston no Plant will vegetate.*

TO the observations in the foregoing chapter, which tend to prove that vegetation is more or less vigorous in proportion

portion to the impregnated state of the atmosphere, with either electric matter or phlogiston, it may be alleged, that heat without phlogiston will produce the vegetables of the torrid zone in these northern climates, and that phlogiston is therefore not a necessary ingredient in the composition of plants.

To make this experiment with accuracy, nothing but the purest dephlogisticated air should be used. Air in this state hath been found by Dr. Priestley five times less impregnated than atmospherical air in this climate. The fact is sufficiently proved by its having supported flame and animal life five times longer than an equal quantity of common air.

This experiment shews the phlogisticated state of atmospherical air; and if to its large proportion we add the causes of still higher
impregnation,

impregnation, which must exist in every hot-house where foreign plants are raised, it is difficult to imagine that these plants are without a great supply of this ingredient, arising from the quick progress of putrefaction: experiment confirms this opinion, which the following extract from Dr. Ingenhoufz shews.

Page 49.—“ The gardeners, by opening
 “ a hot-house early in the morning, which
 “ has been shut close during the night, or
 “ at any time in the day, if the sun has
 “ not shined a good deal on it, are very
 “ well aware of a particular oppression they
 “ feel by entering it. I remember to have
 “ felt it more than once, without even sus-
 “ pecting the cause of it. Dr. Priestley ob-
 “ served this remarkable offensiveness of
 “ the hot-houses with a more philosophical
 “ attention; he tried the air within them,
 “ and found it worse than common air.”

The artificial climate of the hot-house resembles that of the tropical latitudes ; for heat is the first moving principle in warm countries, as well as in the confined air of such houses.

It is probable, that on a comparative trial of the air of a hot-house with dephlogisticated air, the difference might be found as one to seven, or perhaps more, instead of one to five, like common atmospherical air. The following experiment, made by Dr. Priestley, tends to shew that plants will not grow long in dephlogisticated air.

Vol. III. p. 336. —“ On the 10th of September, 1776, I took two sprigs of mint,
 “ and having put each of them into a phial
 “ of rain-water, introduced one of them
 “ into a jar of dephlogisticated air, leaving
 “ the other in a jar of the same size, and
 “ with all other circumstances similar to it
 “ in

“ in common air. For some time I could
 “ perceive no difference between them,
 “ and neglected to take notice of them till
 “ the 10th of October following, when I
 “ found the plant in the dephlogistified
 “ air quite dead and black, and the other
 “ partially so, but the uppermost leaves
 “ were still alive. The dephlogistified air
 “ was diminished one-seventh in its bulk,
 “ and the other half as much.”

The water and sprig of mint, under both
 jars, in this experiment, were in the same
 circumstances, yet it is evident that the one
 exposed to the dephlogistified air died
 long before the other, but how long was
 not ascertained. It is probable, had the
 water been as totally deprived of its phlo-
 giston as the air, this plant would have
 died still sooner ; and there seems much rea-
 son to suppose, that phlogiston is so gene-
 ral an ingredient in the food of plants,
 that

that none will grow without some degree of it in a disengaged and active state, though those which have been nourished by a due proportion, and consequently have a quantity in their composition, may for a time support life in the most pure dephlogisticated air,

C H A P. XII.

The Operation of Manure in promoting Vegetation.

VEGETABLE and animal matters will not contribute to the growth of plants, unless they have become putrid: when this is the case, their component parts are disengaged by the putrefactive process, in which state they yield the phlogistic principle, and are more or less good manures in proportion to the quantity of this principle they contain; therefore animal

D substances

substances which possess it in greater abundance than vegetables, are better manures. All alkaline and absorbent earths are generally considered as manures ; but their action in promoting the growth of plants is very different from putrid vegetable and animal substances, which contain in their composition the necessary principles for the reproduction of plants.

That this different action may be understood, we shall premise a few particulars relative to the properties of alkaline and absorbent earths, and fixed air, and then proceed to their different modes of action on vegetable and animal bodies.

Every alkaline or absorbent earth hath an attraction for acid in proportion to its strength ; when these earths are perfectly uncombined they are caustic, but when saturated with fixed air they become quite mild.

mild*. This fluid, called fixed air, is strongly attracted by all absorbents, and hath been demonstrated by Mr. Bewley, and Dr. Priestley, to be an acid of particular qualities, entirely different from all others †: and as an acid only, we suppose it attracted by absorbents; and when combined with them, the compound may be considered as a kind of neutral: but its attraction for these bodies is weaker than any of the other acids, it is therefore easily decomposed by them all.

Dr. Priestley hath shewn, that vegetable substances contain a large proportion of nitrous air ‡, which is a modification of the nitrous acid; and he hath also proved, that animal substances (the fats excepted)

* See Dr. Black on Quick-lime, &c. Edinburgh Physical and Literary Essays, vol. ii.

† See Dr. Priestley, vol. i. p. 31.—and Mr. Bewley in Dr. Priestley's 2d vol. p. 337, 338.

‡ Priestley on Air produced from vegetable Substances, vol. ii.

contain none of this nitrous air, but a portion of fixed and inflammable. The acid in the composition of vegetables is a most powerful antiseptic *, and must be expelled before they can become putrid, which acid, in the ordinary course of natural decomposition, is disengaged by the vegetable fermentations previous to the state of putrefaction.

The effect, therefore, of an addition of alkaline substance, or absorbent earth, to a mass of vegetable matter, is that of uniting with this nitrous air, which counteracts the putrescent tendency of the vegetable substance; and when the acid is thus drawn from them by these absorbents, the putrefactive process takes place immediately.

If these earths are in a caustic state when applied to vegetable and animal matters,

* Priestley on nitrous Air, vol. i. p. 123.—For further proofs of this acid, see chap. 8. part 2.

they

they bring on putrefaction with great rapidity, as their attraction for acid is then most strong. But even when they are rendered mild by saturation with fixed air, they induce the putrefaction of vegetable matter, by absorbing the nitrous air in their composition, for which they have a much stronger attraction, than for the fixed air with which they are combined; consequently the fixed air, which is a weaker acid, will be disengaged and expelled as fast as the nitrous air and absorbent earths are brought into such contact as to act on each other: and for this reason it is that pulverized lime-stone, without any calcination whatever, hath been found a good manure, though less quick than that which is calcined.

From an over quantity of these absorbents laid on soil, the septic powers may be so increased as to rot the very seeds and

plants put into the ground. This we have experienced in the West-Indies, by giving too great a proportion of marl to a small piece of land planted with sugar-cane; and we are informed, that the same excess hath frequently been committed in this country. The error may be rectified by ploughing a quantity of fresh vegetable matter into the soil, and allowing it to remain in that state for six or eight months, or longer; when the nitrous and fixed airs yielded by it will so saturate the absorbent earth, as to deprive it of its exceeding septic qualities, and consequently the vegetable matters added will be rotted and converted into an excellent manure.

From this it is evident in what manner the great advantages arise from lime, either in a caustic or mild state, laid on land well covered with vegetable matter; and hence the great risque of laying much lime

on fallowed lands, where there are no vegetable substances for it to act upon, and acquire a certain degree of saturation before the seed is put into it. But even under these circumstances, a small quantity will forward the growth of the seed, by accelerating that degree of putrefaction which takes place before it begins to vegetate.

To saturate these absorbent earths fully, when laid on land, is the work of time, and depends on the quantities of matter they meet with, which contain nitrous and fixed air. Their good effects are often visible to the fourth and fifth years, and even much longer, if the ground has not been frequently turned; but when complete saturation hath taken place with the nitrous air of vegetables, no further good effects are discoverable, as they are no

longer capable of absorbing that nitrous air, which counteracts the progress of putrefaction in the vegetable matter, and consequently no longer act as septics.

The decomposition of fixed air from these earths, by nitrous air, renders the mild absorbents as effectual and useful septicics for the purposes of manure as the caustic, though their effects are not so rapid and powerful.

If animal substances are used as manure, their putrefaction is sufficiently quick without the addition of absorbents; but when these are added, they will attract the fixed air in their composition, which acts as an antiseptic while combined with them, and in consequence of its discharge the animal matter becomes putrid with great rapidity.

From the theory of the operation of absorbent earths on vegetable and animal matters, which we have here laid down, it is evident that their action, as promoters of vegetation, is entirely confined to that of inducing putrefaction, and thereby generating the food of plants, by disengaging the component parts of bodies, and consequently the phlogiston contained in them ; which principle we conceive is universally a necessary ingredient in the composition of the vegetable kingdom.

In the earliest state of growth we apprehend a portion of this principle is, by a certain degree of putrefaction, disengaged from the oily and saccharine matter contained in all seeds, which nature seems to have appropriated for the envelopement of this necessary principle, until the plant can send forth roots and branches to take it from the earth and atmosphere.

CHAP.

C H A P. XIII.

Soil improved by Exposure.

THIS method of improving soil shews the impregnated state of the atmosphere : Mr. Tull, in his Essay on Husbandry, recommends a sufficient degree of pulverization as an equivalent to manure added in the ordinary way, though he seems sensible that the effect results not from pulverization alone.

It is evident that the improvement of soil arises principally from the influence of the sun and atmosphere, and that pulverization increases fertility by increasing the surface, to which the principles contained in the air may attach themselves, though no doubt the texture of the soil is rendered
better

better for vegetation by being pulverized. This mode of fertilizing soil may be considered as a slow means of getting from the atmosphere the same principles which are expeditiously given by manure in the ordinary way.

Wherever the atmosphere is most impregnated, there the soil will be meliorated in the shortest time, if equally pulverized by turning up. This fact is well known to those who have attended to the agriculture of the warm climates.

CHAP.

C H A P. XIV.

Some Observations relative to the Moon's Attraction.

WHAT is hereafter mentioned, relative to the moon's influence on the vegetable kingdom, we offer as theory : all the facts we shall adduce in support of this theory, except that relative to the changes of the atmosphere, we know by information only ; but this information we have received through a variety of channels, both English and French, and all of them agree in the particulars we shall take notice of in chap. xxii. of this part.

It is proper to observe, that the following theory of lunar action does not interfere with vegetable circulation, as that will be shewn to depend on perspiration, the natural degree of which is determined by
climate

climate alone ; therefore should the moon's attractive power be supposed out of the question, we must allow that this only evaporation of vegetables is produced by the sun's heat, independent of the moon : but as the action of these two bodies, in all places, bears a certain general proportion to each other, and as the attraction of the one, and heat of the other, seem so well fitted to unite in producing the same effects, *viz.* the perspiration of plants, we think the analogy of nature may lead to suppose them much connected with each other in this operation. This appears in a still stronger point of view, when the manner of their different actions can be so traced as to shew how they may unite to produce the same effects.

That our ideas of the lunar action may be more clearly understood, we shall first
take

take a short view of her influence in promoting the tides, which will facilitate this part of our subject.

C H A P. XV.

Of the Tides.

ALL the planets move round the sun in elliptical orbits, and their satellites in orbits similarly elliptical, though not so regular as those of the primaries. The sun's action in some places coincides with, and in others counteracts, the influence of the moon, by which counteraction the varieties of tides are principally produced. The highest, or spring-tides, are at the new and full moon; the lowest, or neap-tides, are when the moon is in her quarters, or acts in a lateral direction to the line of the sun's direction. When the moon is new, she is between the sun and earth, by which position her attraction co-operates with

with that of the sun in almost a strait line, and her apparent influence is greater than her real by the amount of the sun's attraction, which is, upon a calculation of mean force, nearly in the proportion of 1 to $4\frac{1}{4}$. When she is full, our earth is between her and the sun ; and from the small variation between the plane of her orbit and that of the ecliptic (which is only five degrees), we may consider her as acting in nearly a strait line with the sun and earth, both at change and full. The distance of the moon from the earth, when in the nearest extremity of her orbit, is to that when in her greatest extremity as 69 to 70; therefore the spring-tides at new and full moon are of unequal heights, as the one must happen when she is as 69, and the other when she is as 70.

It is easy to comprehend how the united forces of the sun and moon act on that side
of

of the earth next to them, when the moon is between the earth and the sun; but it is more difficult to understand how their actions unite to perform a nearly equal effect on the opposite side of the earth, so as to occasion the flux and reflux twice every twenty-four hours; and also when the moon is full, and the earth between her and the sun, in what manner tides are produced by the lunar action on the opposite side of the earth from that in which she is: but it is at present sufficient for our purpose that the facts are so *.

When the moon is in the quarters, she will attract in a direction nearly at right angles to a line passing through the sun and earth's centres; consequently the force of the

* It seems unnecessary, in giving a general idea of the lunar and solar action, to enter particularly into these demonstrations; those who wish for more full information may apply to Sir Isaac Newton's works, and Mr. M'Laurin's account of his philosophical discoveries.

moon's attraction on the surface opposite to her will be counteracted by the sun's attraction, which tends to depress and draw the fluids under the moon into the strait line passing between the sun and earth's centres ; and in proportion to the strength of his attraction will the elevation by the moon's influence be diminished, which occasions the neap tides. Their mean height is about six feet seven inches, although the moon in the same situation to the earth would of herself elevate the waters to about eight feet six inches, were not her influence counteracted by the sun's attraction in the proportion of 1 to $4\frac{1}{4}$. Thus we find the sun's attraction in the conjunction and opposition increasing the moon's apparent attraction by an elevation of near two feet, which makes the height of the spring-tides, from their joint force in the full and change, equal to a mean height of $10\frac{1}{2}$ feet, while in the quarters we find his attraction

E diminishing

diminishing the real influence, which, instead of being added to the moon's attraction, is deducted from it, and reduces it in this situation to six feet seven inches.

From these things being thus generally understood, we may not only comprehend the causes of the tides, but easily see that their variations must be considerable between the extremes of spring and neap, and that those variations chiefly depend on the angle, a line drawn through the earth and moon's centres makes with another line drawn through the centres of the earth and sun.

CHAP.

C H A P. XVI.

Why the Tides are not in general so apparent between the Tropics as beyond them, towards the Poles.

ON considering the foregoing chapter it will occur, that the influence of the moon, in elevating the waters, should be generally greatest between the tropics : that it is the greatest there, seems undoubted, and it would also be the most apparent, were there different continents in that part of the Atlantic ocean situated at moderate distances from each other, as the depression on one shore is the cause of elevation on the other ; but in a vast ocean, with a few very small islands, the resistances to the flux and reflux of the waters are so small, that the re-action from them produces no accumulation, and the passages between

E 2

them

them are so very wide and numerous, that by the time a body of water is put in motion in one direction, it is re-acted on in a contrary, or lateral one, by the waters of the former tide, before it reaches any shore sufficiently extensive, on which its elevation can be observed. This is probably the cause of those vast currents to be met with in all seas, of different velocities at different times, in the same or different places, either gliding smoothly, or meeting in opposite directions, which often occasion a rough and turbulent surface, without wind. Their periods cannot be determined, as their directions in different places must continually vary from winds, and different bodies of water, which are daily changing place, and following the influence of the lunar and solar meridian. At the islands of St. Kitt's, Statia, and St. Martin's, situated about the 17th degree north latitude, the tides are hardly visible, in consequence of their being

ing small, and at great distances from the continent. At Grenada, about the 11th degree, they are more considerable, from its being situated nearer to the Spanish main there spring-tides often rise $2\frac{1}{2}$, and three feet perpendicular.

About Trinidad the difference is greater, and in the channel between that island and the main land, called by the Spaniards the Dragon's Mouth, the tides rise frequently six or seven feet, or more.

The common tides rise so high on the continent of Surinam, and Isaac-cape, &c. about the 5th degree north, as to fill the canals which keep their sugar-mills at work the time of low water.

At the island of Bouton, situated in 5 degrees 40 m. south latitude, the tides rise fifteen feet perpendicular *; we may also

* See the observations of Captain Woodes Rogers, in his *Voyages round the World*.

conclude, that at Sumatra, Borneo, and other places near the same latitudes, they rise and fall equally, under equal circumstances of the position of land.

C H A P. XVII.

The foregoing Chapters applied to Air.

HAVING seen the moon's influence by her attraction on the waters upon the surface of the earth, it follows, that all bodies will be acted upon by the same cause, as matter, under all forms whatever, is subject to gravitation. Air, one of the most moveable and light fluids we know, is subject to these laws, and will be elevated in proportion to its gravity.

Water is capable of being raised $10\frac{1}{2}$ feet perpendicular by the sun and moon's combined attraction; and if we suppose our

atmosphere equal to the weight of 16 miles perpendicular, of air equally dense as at the surface throughout the whole, or of any other height, the same attraction which is capable of supporting a column of water $10\frac{1}{2}$ feet high will suspend a column of air of the density and height above-mentioned nearly to five miles, and $\frac{1}{3}$ of a mile, or a column of any other fluid to a perpendicular height nearly equal to one-third of that which the whole pressure of the atmosphere can raise them to.

From the above elevation of the air it seems natural to suppose, that the mercury in the barometer should sink every new and full moon, in proportion to the diminished weight of the atmosphere; but this is not found to be the case: and although the perpendicular height of the barometer does not discover these changes in the weight of the atmosphere, yet it should

manifest itself in the heat of boiling water, and the effervescence of fermenting fluids, if the changes are considerable. It is well known that water boils with less or more degrees of heat, in proportion as the pressure on its surface is diminished or increased; and that the effervescence of fermenting fluids is increased or diminished by the same cause, is also well understood.

We made several attempts to ascertain this fact with boiling water, but the difference was not discoverable. We had next recourse to fermenting fluids, as a more delicate test, and after a regular attention for several months, to the surfaces of at least thirty vatts, which were constantly filled with fermenting liquors, kept in the same degree of heat, and mixed in the same proportions for the distillation of rum in one of the Sugar-islands, we thought that a more brisk effervescence at new and full moon,

moon, than at other periods, was discoverable. The same remark we have since heard made by others; yet the difference was so little, that it is still a doubt with us if it could any thing reduce the boiling point of water.

C H A P. XVIII.

How the perpendicular Pressure of the Atmosphere is kept up, notwithstanding the tendency of the Moon's Attraction to diminish it.

AIR is a compressible fluid, and occupies more or less space according to the resistance it meets with: the effect of the moon's attraction is to diminish the weight of the atmosphere, by elevating the column of air immediately under her meridian. In this way the air is slowly rarified from top to bottom, in proportion as
the

the moon's influence increases, not only towards the full and change, but also towards the lunar meridian of each twenty-four hours.

It is well known, that bodies on the surface of the earth, as well as the earth itself, retain much air in their cavities and pores, and even contain it intimately blended in their composition, which they part with in greater or less quantities, according to the pressure on their surfaces ; therefore when the atmosphere is most ponderous, its weight will drive the most dense air, which is constantly nearest the surface, into those cavities and pores of all bodies with which it comes in contact ; and as the pressure diminishes by the moon's attraction increasing, as she approaches to her meridian, that air which was seemingly fixed begins to expand itself, and follows the rising column, until the increased perpendicular

dicular height of the column adds a weight equal to the moon's increased attraction, or suspending power; by which means the atmosphere will at all times be nearly of the same density and weight at the surface of the earth, as the increased height of the atmosphere, when the moon's action is greatest, will be exactly equivalent to that attraction. When she declines from her meridian, and her attraction begins to diminish, it will operate in the same manner as an additional weight given to the atmosphere; and those particles which had expanded themselves, or others, in their stead, will be forced back into their former lodgments; by which the weight of the atmosphere, or pressure on the surface of the earth, will at no time vary so much as at first view might be expected.

Besides this expansion of the air upwards, a lateral one will also take place,
as

as the air, removed to a distance from the lunar meridian influence, will press in to restore the equilibrium. This consequence is so very evident, that seamen look for an increase of wind * when the moon rises to her meridian, particularly if it is calm, or nearly so.

C H A P. XIX.

The Effect which we suppose the above Motion of the Air has on the Growth of Vegetables.

PLANTS, by their branches and foliage, expose a very large surface to the contact and influence of the air, all of which are capable of discharging perspiration in proportion to the warmth of their situations.

* Dr. Mead makes this observation.

On the quantity of perspiration discharged by plants depends the quantity of moisture they are capable of imbibing. This fact is proved by Dr. Hales in his *Vegetable Statics*; it is therefore to be observed, that the discharge of perspiration, is the cause of absorption and circulation, which take place but in proportion to it.

The sun and moon, by occasioning the perspiration of plants, do actually promote their internal circulation, as the vacuities produced by this discharge must be supplied by the succeeding fluids; consequently while perspiration continues, circulation and absorption must be the effect, and thus the sun and moon act as first causes in the growth of the vegetable kingdom.

Dr. Hales demonstrated by various experiments, that plants imbibe large quantities of air, and that that subtile fluid re-
tains

tains its elasticity in passing through all their parts, and may be discharged from the hardest woods, by only taking a part of the pressure of the atmosphere from off their surfaces.

From these facts, and the effects of solar heat and lunar attraction, we shall offer the following theory of vegetable circulation.

We have already observed, that the difference between the plane of the sun and that of the moon is about five degrees; from which small difference they may, generally speaking, be considered as making their progress on the earth within nearly the same limits, and that their influence will consequently bear in all situations nearly the same general proportions to each other; or in other words, that these places which are warmest will have the greatest
lunar

lunar influence, and those more removed from the limits of the sun's progress will also suffer a diminution of the moon's power.

Between the tropics, the influence of both sun and moon are greatest; and as the moon advances from her quarter towards the full, she daily continues to act stronger, by gradually elevating the column of air under her meridian higher and higher, until she arrives at the full, when her meridian influence is the greatest.

This elevation of the air lets loose that which was seemingly fixed in bodies, as each particle will expand itself in proportion to the diminished pressure; and those contained in vegetables which retain their elasticity will, from their dilatation, force a discharge of perspiration even to the extremities of the highest trees; in
consequence .

consequence of which absorption must be proportionally increased, and air, water, phlogiston, or whatever food the earth furnishes proper for vegetation, will be absorbed and carried through the course of circulation. These effects naturally follow from such alterations in the perpendicular height of the atmosphere as we have pointed out. According then to this theory, plants discharge more copiously their perspiration by the air in their composition being expanded twice every twenty-four hours, and the discharges are diminished an equal number of times within the same space, by the external air returning to its former perpendicular height. These discharges, although in equal and regular times, may occasion a variety in the vigour and circulation of vegetables, independent of what results from the expansion and contraction of the air and fluids in their composition by heat and cold.

We

We may further suspect, that the degree of moon-light by which they are influenced may also make their circulation at different times more or less vigorous: it is to be wished, that it were tried what effect the rays of the moon have on the growth of the vegetable kingdom.

C H A P. XX.

Vegetation proportioned to these Causes in different Climates.

THE near coincidence of the lunar and solar planes makes it more than probable, that the action of these bodies hath been intended to assist each other.

The lunar power seems to co-operate with the sun's dilating and relaxing heat, to promote the perspiration of plants, by assisting the expansion of the air in their
F composition,

composition, with removal of external pressure, while the sun's warmth keeps their fluids in an attenuated and perspirable state. Thus we suppose, by the joint action of the sun and moon, the necessary perspiration in different climates *; for the growth of such plants as are natives of them, is accomplished, and becomes greatest where the greatest quantity of matter is generated by the sun's heat for their production.

Between the tropics, where these luminaries act with full force, vegetation is quickest: as we recede either to the north or south, beyond these lines, the rapidity of putrefaction, and the progress of vegetation, regularly decrease in proportion as the distance from them is increased; and thus by comparing the state of vegetation

* From the experiments of Dr. Hales, the same plant varies in its discharges, without its health being hurt.

in different countries with the degree of solar and lunar influence in them, we shall find our theory corresponding with the state of facts.

C H A P. XXI.

Of the Moon's Influence on Vegetables counteracted by Cold.

THE northern climates have as much of the moon's influence in winter as in summer, yet vegetation stops when the sun's heat is diminished to a certain degree.

By the theory of vegetable circulation proposed, the moon is considered as capable of influencing the growth of plants principally by the changes which she induces in the state of the atmosphere, but the effect of these changes must depend on the condition of plants at the time they are acted upon.

Perspiration we have already considered as the primary cause of circulation and absorption; but this primary cause cannot exist, except under certain circumstances of heat and fluidity. The absence of the sun's influence to a certain degree will therefore totally prevent this discharge, and consequently bring on an entire stoppage of motion; and the fluids thus stagnated will by the cold become dense and adhesive, while the rigidity of the solid parts will also be increased. Both of these causes must powerfully counteract the expansion of the air in their composition, and absolutely prevent its enlargement of volume by so small a cause as the alteration of pressure, unassisted by a due degree of heat.

When the sun returns to our hemisphere, his influence, by the combined action of heat and light, soon removes the obstructions above mentioned, and the perspiration

tion

tion and growth of plants proceed in consequence with a rapidity proportioned to these causes, which are greatly inferior to the action of the same causes in the tropical climates, except for a short space in the middle of summer, when the sun is in the northern tropic, at which time we have in this climate more of his light than countries situated near the equator.

If a tree is cut down in winter, and left in the air, it will vegetate as early in the spring as other trees of the same kind; and this will continue to go on while the air and fluids in its composition are capable of expansion from the degree of heat then influencing them; but as its discharges are not supplied by the absorption of fresh matter, the tree is soon exhausted, and dies.

If a branch is cut from a tree in winter, and gradually introduced into a warmth

not greater than that of summer, it will vegetate by that external application of heat; and if the plant from which it was cut be properly lifted, and placed in the same temperature, and supplied with water, it will also vegetate, and continue to do so.

These facts strongly prove that perspiration is the cause of circulation and absorption in plants, and that these causes, which produce this discharge, act as primary or enlivening principles of the vegetable kingdom; consequently growth can only take place in proportion to the degree of their influence. The action of the leaves of plants, in dephlogisticating impregnated air, has something the appearance of a vital principle; but this power is not inherent in the plant, but is the effect of the action of light on plants.

These

These considerations seem sufficiently to point out why lunar influence can have no effect without a certain degree of heat; and that the moon's action in summer is less remarkable here than in the torrid zone, evidently results from the position of her orbit, by which her greatest action, like that of the sun, is nearly confined to the tropical climates.

C H A P. XXII.

Facts in proof of the foregoing Theory.

IN the tropical latitudes there is generally a fall of more or less rain at each change and full moon, unless the weather be exceedingly dry; and even then it seldom passes without a clouded sky, and evident changes in the state of the atmosphere.

In these climates, if timber of the hardest kind is cut at either new or full moon, it

is found more full of moisture, or sap, than at other times, which soon decays the wood by running (we suppose) into a kind of fermentation; whereas if the same kind of timber is cut when the moon is in her quarters, it will be found more solid, and of greater duration. This is generally considered in the torrid zone as a fact, by those who cut and prepare hard wood for sale, and from many of them we have this information.

The manufacturers of castor oil in some of the Sugar Islands gather the nuts at change and full moon, and generally find them yield from a fifth to a fourth more at these times, than when the moon is in her quarters. This information we also have from the manufacturers themselves.

In transplanting trees in these climates, if it is done at the quarters, they seldom
succeed,

ſucceed, or at leaſt they continue languid and feeble for a long time ; but if done at either the change or full exactly, they generally thrive well ; and this we ſuppoſe to ariſe from the following cauſes :

Before the change and full the dilatations are daily growing greater, by which a too copious diſcharge is made before the plant can draw from the earth any ſupply ; whereas after the change or full the dilatations are daily diminifhing, and the plant is not by over-perſpiration exhausted of the large ſhare of juices with which it was filled by its greateſt dilatations, before taken from its former place of growth.

In theſe countries it is alſo aſſerted (particularly among the French, who are generally more attentive to theſe *minutiæ* than the Engliſh), that the period of the moon ſhould regulate the planting of moſt ſeeds,
and

and gathering of herbs for medical purposes. That these periods are by them attended to, in planting and gathering, is an undoubted fact, and the generality of the practice is a strong presumption in favour of its justness.

If we consider that astonishing power which plants possess when influenced by light, we are naturally led to view these assertions with a greater degree of faith; for it is impossible to say *a priori*, what effect light and darkness may have in diminishing or increasing the qualities of plants.

C H A P. XXIII.

*Reasons why Vegetables are less capable of
supporting Changes of Climate than Ani-
mals.*

VEGETABLE circulation, or life, hath already been shewn to depend on the action of external causes, by which the discharge of perspiration becomes the immediate promoter of circulation. This is the only natural mode of evacuation of the vegetable kingdom; therefore when it is diminished by cold, or augmented beyond its due degree by an excess of heat, plants are flung into bad health, and nothing can restore them to full vigour but the increase or diminution of this discharge to its proper quantity. For this reason it is, that vegetables can thrive in such climates only as furnish a due proportion of food, and
occasion

occasion that degree of perspiration which is exactly fitted to their particular organization.

From the simplicity and confined state of vegetable evacuation, there is great reason to suppose their food of a uniform and homogeneous nature ; were it otherwise, it is difficult to imagine that all its superfluous parts could with equal facility be discharged by perspiration. Water, therefore, impregnated with some principle necessary to vegetable life, seems to enter the composition of plants as a vehicle only, which, like phlogisticated air, is in the course of its circulation deprived by the plant of the matter with which it is impregnated ; and when this is accomplished, the aqueous parts charged with the worn off matter, which results from the friction of the circulating fluids, is like the dephlogisticated air discharged as an excretion,

This

This is confirmed by an experiment of Dr. Hales's; he collected the perspiration of many plants, such as fig, apple, cherry, apricot, and peach trees, rue, horse-radish, and parsnip, &c. all of which were very clear, and without any apparent difference, though from plants of such different qualities. It nevertheless became sooner putrid than common water, which is a proof of its containing some heterogeneous matter*.

Vegetables can take into their composition, matters dissolved in the water they imbibe, which may be productive of their death. When such matter is absorbed as can neither be assimilated nor discharged by perspiration, circulation is obstructed, and either the whole plant, or those particular parts in which such obstruction is situated,

* See Vegetable Statics, vol. i. p. 49.

must languish and die. These reasons seem sufficiently to point out why plants adapted to particular places, are incapable of accommodating themselves to situations where they are differently influenced.

Animals have a variety of evacuations, and are therefore less affected by change of climate. If perspiration is diminished by cold, the urinary and pulmonary discharges are augmented; and when this evacuation is increased by warmth, these discharges are diminished. In this manner the bodies of such animals as are capable of these evacuations are accommodated to different climates; by which, together with the intestinal outlet, the most heterogeneous matter taken in as food, is emitted after its nutriment is extracted.

From the complicated construction of animal bodies, we are at first view led to sup-

pose them more subject to derangement than they would be, were they more simply fabricated; but this does not seem to be the case. That very complication is the source of their great powers in extracting their nutriment from the most heterogeneous food, and discharging their fæces by various outlets, fitted to their different qualities, and the variety of climates to which they may be exposed.

C H A P. XXIV.

C O N C L U S I O N.

FROM what hath been said in the foregoing Chapters, it is apprehended that the following particulars are rendered highly probable :

In the first place, that a certain degree of phlogiston is necessary to vegetation,
and

and that the quantity disengaged in any given district of the globe is exactly in proportion to the degree of solar and lunar influence in that district.

Secondly, that the action of manure in promoting vegetation bears a certain proportion to the quantity of phlogistic matter contained in those manures; and that fossil septics act by promoting the putrefaction of vegetable and animal bodies, which separates the component parts, and by that means only act as manures.

Thirdly, that the growth of plants is affected by climate, in proportion to the degree of light and perspiration which results from the sun and moon's joint influence.

P A R T II.

Of Aliments, their Digestion, and
Effects on Animal Bodies, relative
to Climate.

C H A P. I.

The Object of this Second Part.

ON the productions of the vegetable kingdom depend those of the animal; as the latter cannot exist beyond a due proportion to the general state of the former; and as the body of every animal first existed in a vegetable form, from which it hath been changed by the process of animalization once or oftener, it seems naturally to follow, that the state of animal

G

bodies

bodies must be influenced by the qualities of their nourishment ; and as the qualities of that nourishment depend on climate, the condition of the animal must not only be affected by the same cause through its food, but also by the immediate action of those causes, which so much influence the health and growth of vegetables.

The object therefore of the succeeding Chapters, is an attempt to examine into the changes induced on the human body by food and climate, and to point out some of their varieties, and the causes which produce them.

C H A P. II.

Division of Aliments.

BEFORE we begin this examination, it seems proper to make such a division of food, as will assist in explaining

ing what is meant by different aliments.

Vegetables as food, we shall consider under two heads or classes, and these classes we shall distinguish by their general properties. In the first, we include all vegetables which are capable of the vinous and acetous fermentations, or of the acetous only, without the vinous. In the second, we shall comprehend such vegetables as emit an alkaline vapour first, and then run more or less into an acid state, before putrefaction takes place, or into putrefaction, without any previous discoverable degree of acescency.

We shall next divide animal substance into three classes, by the names of, Half Animal Food, Simple Animal Food, and Compound Animal Food. By the first is meant, that which is between vegetable and animal, yet partakes of the nature of both,

without being either; such is the milk of herbaceous animals.

By the second, is meant the flesh of those animals which feed on vegetables; such as cattle, sheep, &c.

The third comprehends those which are carnivorous, whether biped, quadruped, fish, fowl, or reptile.

C H A P. III.

Experiments relative to the Division of vegetable Aliments.

BY our division of vegetable aliments, the second class comprehends those plants generally stiled alcalescent and aromatic; yet the following experiments lead us to suspect, that many of these yield an acid, after the discharge of their most volatile part by coction, or long standing;

and that perhaps very few, if any, are totally void of some small degree of acescency; but we apprehend that in most of them the acescent qualities are so trifling, and the alcalescent so very strong, that the former can have little or no effect in animal bodies, when those plants are used as food.

A turnip deprived of its skin, was well boiled, and then broke down in a tea-cup, with cold water sufficient to reduce it to a thickness like that of rich cream.

Another turnip also deprived of its skin, and raw, was cut in thin slices, and put in a second tea-cup, to which a quantity of water was added sufficient to cover it.

The skins of these turnips were well washed, then cut in small pieces, and put raw in a third tea-cup, with water enough to cover them.

In a fourth cup, was put the skins of two turnips which were well boiled, and cold water added sufficient to cover them.

In three days the boiled turnip in the first cup began to emit an agreeable smell, and for several days the water squeezed from it gave a red tinge to the syrup of violets; after this, the acidity began to diminish, and in four days more it emitted a putrid smell. About the sixth day, the raw turnip emitted a vinous smell, and on the seventh the water from it also turned the syrup of violets to a light red; but previous to these appearances, a slight smell like that of the skins was emitted, which shewed, that even the turnip itself contained a very small degree of alkaline matter.

The raw skins smelt for several days as if fresh, and the same smell increased and went on, without any appearance of acid;

about the tenth day there was a kind of diminution of this smell, but no perceivable acidity, the putrid smell returned, and the skins were dissolved into a mucilage of most disagreeable odour.

The boiled skins resisted all change till about the seventh day; they then began to emit a kind of acid smell, which was so exceedingly weak, as to be discoverable by the odour only, and not without particular attention; from this state they changed to the putrid, without stronger proof of acid.

An onion was cut in thin slices, then chopped very fine, and mixed in a wine-glass, with a sufficient quantity of pure water to make it into a pulpy consistence. No change to acidity was perceivable in this mixture, probably from the strong odour which it continued to emit until dissolved by putrefaction.

Another onion was well boiled, and mixed in a second wine-glass with an addition of cold water, with which it was also stirred into a pulp. This emitted no smell, as its volatile part had been dissipated by the heat. About the fifth day it began to yield a kind of vinous smell, which became more and more perceivably acid for near six days; it then gradually disappeared, and putrefaction came on.

A quantity of common mustard in powder was mixed with water, and put in a wine-glass; an equal quantity of the same mustard, mixed with a greater proportion of water, was boiled until the loss by evaporation reduced it to the consistence of the cold mixture. The raw mustard emitted a very volatile pungent odour for near four weeks; the boiled mustard had lost its pungency, and continued without smell to the ninth day, about which time a very faint acidity was discoverable by strict attention
to

to the smell; after which it became putrid, and went on to the last stages without discovering any further acid. The raw mustard arrived at perfect putrefaction without any palpable degree of acidity.

These experiments were made in the month of June, when the weather was remarkably warm.

C H A P. IV.

Of the Fermentations.

AT present we must consider the vegetables spoken of as belonging to the first class, which are capable of both the vinous and acetous fermentations, or of the acetous only, without the previous performance of the vinous.

The first fermentation is attended with a degree of heat considerably above the temperature

perature of the surrounding atmosphere, and this heat increases in proportion to the violence of the effervescence, which determines the duration of the process ; but this last circumstance is regulated by the density of the mixture, and temperature of the place in which the body is set to ferment.

When this intestine motion is over, and the vinous spirit perfectly formed, if the liquor is allowed to remain at rest, the acid fermentation soon begins to discover itself, particularly if the temperature, in which the vinous or first fermentation took place, was so great as to hurry it on with too much rapidity. This second fermentation is attended with greater warmth than the former, and that very fluid which by distillation would have yielded a vinous spirit, now gives an acid, which hath been generated by the second fermentation. In a heat of 90 degrees by Fahrenheit's thermometer,

mometer, the vinous, or first fermentation, is so quickly run through in the open air by unboiled vegetable juices, as often to pass unperceived when the liquor is very thin, and possessed of little tenacity; whereas in a temperature about 60 or 62 degrees the vinous fermentation comes on moderately, and requires a long time for being completed.

After vegetables pass the second stage, or acid fermentation, the putrid and last succeeds, which is common to both vegetable and animal substances; and in a heat about 108 or 110 degrees of the same thermometer, the acid soon yields to putrefaction, which in that temperature comes on with rapidity, but in much less degrees of heat, the acid, like the wine, loses its qualities more slowly*.

The

* The putrid fermentation in vegetable substances hath been supposed to generate heat; but this does not seem to be

The vegetables of the second class pass into putrefaction in the same manner with those of the first, yet these different classes consist of some different component parts, or of the same parts very differently proportioned. As those of the first class undergo a process to discharge a considerable quantity of matter before they are advanced towards their dissolution, as far as those of the second, yet they are similar in the process of putrefaction, and by distillation yield the same salts, not only with each other, but with all animal substance whatever; may we not therefore consider those of the first class after the two first fermentations, as more assimilated to the nature of animal substance; and that those of the second by their nature approach more to animal matter, as they are in a very great degree with-

be the case; no heat is produced by the putrefaction of animal matter; and vegetable mixtures, when they pass the acid state, return to the temperature of the atmosphere.

out those qualities which distinguish the first class so remarkably from animal substance ?

These reflections seem to make it a reasonable inference, that the two first fermentations or changes are in some way performed in the course of the digestion and assimilation of vegetables of the first class, and in those of the second also, in so far as they are capable of these fermentations.

We shall endeavour to follow this idea, and shew that they actually do undergo these changes in the course of animalization.

C H A P. V.

*Of the Changes of vegetable Matter when
taken into the Body as Food.*

MOISTURE as well as heat is necessary to the progress of fermentation; but as a sufficient degree of both for that purpose are never wanting in living animal bodies, we need not take up time in ascertaining how much is necessary.

From the rapidity of the first fermentation, in a temperature equal to that of animal heat, we may reasonably conclude that its progress in the stomach is little attended to, particularly when blended with many other substances, which is generally the case; yet after eating considerable quantities of rich summer fruits (unmixed with animal matter) which produce the vinous spirit in the greatest abundance, the most
evident

evident proofs both by the smell and taste of the eructations in the course of their digestion, discover that the vinous fermentation is actually performed in the stomach. Aliments of the farinaceous and green vegetable kind, do not yield a vinous taste when vomited up, but one something different, which is rather similar to wort or new beer; this is the real taste of these substances when fermented out of the body, and is evidently discovered after eating plentifully of bread and pot herbs, without any mixture of animal matter; their retention in the stomach after brought to this state is attended with acid, into which it is changed by the heat with greater or less rapidity, in proportion to the weakness or strength of the habit.

The real and frequent existence of this acid in the stomach is indubitable; and this fact, together with what we have observed above, relative to the eructations in the
course

course of digestion, are strong proofs that the first fermentation hath actually passed in the stomach, previous to the formation of this acid, as no art hitherto known can alter the succession of the vegetable fermentations, or renew them a second time in the same body, when they have once been completed.

The stomach and intestines do not appear the place intended by nature for perfecting this second stage or change to acid, as the production of it there is very generally attended with uneasiness; it is therefore from this consideration presumable that the chyle hath not undergone the acid fermentation, when absorbed by the lacteal vessels; and as animal substances are capable of the putrid or last fermentation only, the middle change or transition to acid we suppose is performed after the absorption of the chyle, and before its assimilation into animal matter.

C H A P. VI.

*That the Chyle and Milk of the same Animal
are the same Fluid.*

THE chyle and milk of the same animal have been by some considered as very different fluids, while by others a contrary opinion is maintained. The last of these seems most probable, and we apprehend the following facts will prove it strongly.

Dr. Young hath in a very satisfactory manner proved, that acid abounds in the milk of different animals, in proportion to the quantities of vegetables they eat*; and
he

* Altera opinio, scilicet, lac ex novo chylo recens in sanguinem ingressu oriri, magis est probabilis; nam magis vel minus lac acescit, pro natura alimenti: Hoc sæpe expertus sum in lacte canis, nunc cruda carne, nunc vegetabilibus folis, pastæ; priore cibo, lac putrescens, posteriore ab initio acescens, fuit.

H

Lac

he hath also shewn, that the milk of such animals as are perfectly carnivorous will not run into acid, but become directly putrid *. This evidently follows in consequence of the acid fermentation having been performed previously in the herbaceous animal, which was the food of the carnivorous one ; therefore the same matter cannot undergo the same process a second time. On this principally depends the difference between vegetable and animal substances, as food, which we shall hereafter more fully explain.

To ascertain the state of the chyle of herbaceous animals, when ready to be mixed with the blood, we cut through the tho-

Lac etiam omnium animalium, quæ ex vegetabilibus nutriuntur, acescens est.—Dr. Young de Natura et Usu Lactis in diversis Animalibus, caput viii. sect. 1.

* Si folis vegetabilibus, lac acescens ; si vero carne nutriatur canis, alcalinum est ; adeo ut recens lac chartæ succo caryophyllorum imbutæ viridem colorem sæpe inducat.—Same book, sect. vi. de Lacte Canino.

racic

racic duct of a cow, and squeezed forward
 the chyle from the receptaculum chyli.
 In our first and second attempts, the quan-
 tities obtained were so small, and so much
 mixed with blood, that no experiments
 were made with them, lest they should
 lead to a fallacious conclusion. Our third
 trial, which was on a cow newly taken
 from grass, proved more successful, though
 it still had a proportion of blood: but
 reflecting that should there be any acef-
 cency in the chyle, this mixture would
 rather diminish than promote it, we began
 our experiment. The quantity did not
 exceed two tea-spoons-full, to which were
 added three more of pure water, to prevent
 exsiccation. After mixing the chyle and
 water, which amounted to five tea-spoons-
 full in all, they were put in a small wine-
 glass, and covered lightly with a piece of
 paper. This mixture stood seven days
 without any sensible change; on the eighth

it began to emit a kind of vegetable smell, which became vinous on the ninth ; on the tenth the smell was something acid, which became rather more so the three succeeding days ; but the smell even to the time of putrefaction, which began on the fourteenth day, was never distinctly acetous, but continued mixed with a vinous odour.

These circumstances may, we apprehend, be accounted for in the following manner :—Animals, like cows, which eat herbage only, and that in great quantities, may have the first fermentation of the whole vegetable mass imperfectly accomplished in their stomachs and intestines ; a proportion of the unfermented juices will consequently be mixed with the rest, and absorbed by the lacteal vessels*.

In

* The account given of a wine made from mare's milk by the Tartars, and some other eastern nations, may be accounted for from Dr. Young's Experiments, by which it appears, that

In the second place, the blood which was mixed with the chyle would get a putrescent tendency, and absorb the acid as soon as formed, which acid would have been disengaged had the chyle been free of all animalized matter. This seems confirmed by the great time which elapsed before any degree of putrefaction took place, although the experiment was made in the end of June, and beginning of July, when the weather was very warm; and it may with great reason be supposed, that

that the milk of the non ruminantium is less acedent than that of ruminating animals. From this circumstance the milk of the non ruminantium seems still capable of a considerable degree of the vinous fermentation, which retards its progress to acidity; therefore something of a spirituous nature may be expected from it. The following quotations from Dr. Young may set forth the fact:

Seçt. III.—Lac ruminantium, etiamfi multum mucilaginosæ partis continet, tamen magis est acedens, quam lac non ruminantium.

Mucilaginosæ pars lactis ruminantium facile separari potest, vel sponte, vel variis coagulis.

In lac vero non ruminantium, hoc vix obtinere potest, nisi addantur acida, dum lac coquatur.

the mixture of animal juices in the chyle would have emitted a putrid smell in half that time, had not their tendency been counteracted by the acid of the chyle.

This experiment, together with those of Dr. Young, mentioned in the notes, and the acefcent state of the milk of herbaceous animals, all taken together, amount to very strong proof that the second, or acid change, is performed by the chyle after its mixture with the blood.

C H A P. VII.

Of the Change to Acid in the Chyle.

FROM what hath been said, it is probable that a change to acid in the chyle of herbaceous animals doth actually take place, or the matter contained in such vegetable juices as are capable of producing

an acid could not be discharged ; and this must be the case before it can be assimilated into animal substance. How this discharge is accomplished may, we think, be explained in the following manner :

It is evident, that no degree of effervescence can take place after the mixture of the chyle with the blood ; its separation must therefore be affected by other means ; and these means, we suppose, are absorption, by trituration with some component matter in the body ; and that the oily parts are those which do actually absorb, entangle, and blunt the acid as soon as formed, will more evidently appear in the following chapter. The chyle thus losing its acid, and the watry parts going off by the excretions, the remaining matter is in some degree animalized, or rather so assimilated as to be rendered fit for uniting with, and forming the different parts of animal bodies,

dies, as it hath now got quit of its vegetable properties, and in that state is similar to animal substance, both in its fermentation and product.

The effects of vegetable food on animal bodies clearly follow from some qualities peculiar to them as vegetables; these qualities seem to be the power of generating an acid, which is afterwards found in the body.

If we attend to the nature of animal substances, which are made up of the nutritious parts of vegetables only, that have undergone the two first fermentations, or changes, we are led to consider the last, or putrid in them, as a continuation of the same train which would have taken place in the vegetable itself; but from being put into circulation, and as it were brought from vegetable into animal life, it hath
 3 been

been prevented ; and when that circulation stops, which counteracts its natural tendency, it will run into putrefaction, as the consequence of having undergone the two first fermentations previously.

C H A P. VIII.

Of the Acid in Animal Bodies.

IT is a well-known fact, that acids combined with oils give them firmness, and even solidity. The fat of herbaceous animals is an oil in a concrete form, which by distillation yields a phlegm that is highly acid : if this acid is entirely dissipated, or nearly so, by repeated distillations, the dense fats become fluid oils ; nor can the smallest portion of a volatile alkaline salt be got from the fat of herbaceous animals, when thoroughly deprived of all fleshy and membranous parts*.

* See Macquer's Chemistry, Analysis of Animal Fats, and Observations thereon.

Hence

Hence it is evident, that although fats are parts of animal bodies, yet they possess not the same properties with the other parts of animal matter. From a deficiency of this acid in the fat of carnivorous animals, their oily parts are more fluid than those of the herbaceous kind; and when a putrescent tendency in the body is general and strong, the fats become more fluid from a want of this acid: hence those who are far gone in consumptions and scurvies, discharge an oil with their urine, which floats on its surface in very small globules.

This acid being found in so palpable a state, proves beyond a doubt, that the transition to acid hath been actually performed before animalization took place.

By the different degrees of density of the fat of herbaceous, simple carnivorous, and compound carnivorous animals, we
may

may perceive the gradual extinction of the acid through those different stages, in proportion as they become further removed from the vegetable kingdom.

Dr. Priestley hath discovered, that vegetables yield a large proportion of nitrous air*; and he hath also found substances perfectly animal to yield no nitrous, but a proportion of fixed air, though the bulk was inflammable†.

He has given a proof of the antiseptic power of nitrous air, by its having restored mice, in some degree putrid, to a sound state, and preserved them twenty-five days in the middle of summer, without any smell of putrefaction even at that time‡. Nothing can more strongly than this ex-

* Priestley on Air from Vegetable Substances, vol. ii.

† Same book, on Air from Animal Substances, vol. ii.

‡ Observations on Nitrous Air, Priestley, vol. i. p. 123 and 124.

periment shew the antiseptic power of nitrous air; which fact being established by Dr. Priestley, it remains to be proved, that its presence in greater or less quantity, in animal bodies, determines the time they require to become putrid.

This nitrous air, which is yielded by vegetable substances, and not by those which are perfectly animal, we shall also find by Dr. Priestley's experiments to be produced from such bodies as are in the intermediate state between vegetable and animal, and in greater or less quantity, in proportion as they approach, or are removed from the vegetable state.

Eggs contain a proportion of nitrous air*; therefore resist putrefaction a con-

* Dr. Priestley does not mention the kind of eggs he made use of in the experiment, from which we suppose them common pullet eggs, as those of carnivorous fowls would not yield nitrous air. Two measures of common air, and one from eggs, occupied the space of two and a half,

siderable

siderable time longer than the flesh of granivorous fowls.

Milk is rather less animalized than eggs, and contains rather more nitrous air*; therefore, under similar circumstances, resists putrefaction proportionally longer than eggs when broken, which is necessary for an equally free contact with the external air.

We have mentioned the fat of animals, as the repository of the vegetable antiseptic acid. Dr. Priestley found, that hog's lard gave a large proportion of nitrous air, which, he says, was almost as strongly nitrous as that produced from metals: had he tried the firm fat of mutton, or beef, he would probably have found it to yield rather more than the hog's lard, as the

* Two measures of common air, and one from milk, occupied the space of two and one-fourth only.—Priestley on Air from Animal Substances, vol. ii. p. 154 and 156.

bodies of these animals are more immediately formed from the simple vegetable qualities. The brain of a sheep, which is also a kind of fatty substance, yields nitrous air; but from the quantity contained in hog's lard, there is reason to suppose, that the fat of the same sheep would have yielded much more.

Distilled water was found to imbibe one-tenth its bulk of this nitrous air, which gave it a remarkable acid astringent taste.

The Doctor's experiments co-operate with those of Mr. Bewley*, to prove that this nitrous air is a certain modification of the nitrous acid with phlogiston, and that it is deprived of its elasticity by mixture with common air, or water. Since therefore nitrous air is proved to be a modification of the nitrous acid, and this acid so modified is found in vegetable, and not in animal

* Priestley, vol. i. p. 317.

bodies,

bodies, except in the fat or medullary parts, it seems highly probable, that the antiseptic qualities of vegetables arise from this nitrous acid in their composition*.

Besides the experiments of Dr. Priestley, which prove the existence of an acid in vegetables, which he produces in the form of air, the same acid, still differently modified, is got by the second fermentation; and by simple distillation all acedent vegetables yield an acid without the process of fermentation, which acid mixes with the water from the plant, and com-

* Mr. Macquer, under the head of Chemical Decomposition, says, that “ Sometimes one and the same plant “ contains salts analogous to all the three mineral acids, “ which shews that the vegetable acids are no other than “ the mineral acids, variously changed by circulating “ through plants.”

The mineral acids are generally allowed to be convertible into one another; therefore, although this acid appears under a nitrous form when got from plants, yet it may have been under a vitriolic one when taken up by the vegetables.

municates

municates its taste in the same manner that nitrous air does, when it impregnates distilled water*.

Notwithstanding these proofs, it may be said, that the nitrous qualities of the air from vegetables, in Dr. Priestley's experiments, result from the nitrous acid made use of: were this really the fact, nitrous air should also have been produced when the same acid was employed with animal substance; but this was not the case. It may also be alleged, as nitrous air is a modification of the nitrous acid with phlogiston, that this principle contained in vegetables unites with the acid which is added, and forms the nitrous air got from vegetables. Animal substances contain the phlogiston in a more easily separable state, and in greater quantity than

* See Macquer's Chemistry. To analyze vegetable substances, instanced in guaiacum wood.—Vol. ii. chap. vi. process 1.

vegetables ;

vegetables ; therefore when nitrous acid is added to them, nitrous air should be produced ; but this is not found to be the case.

There is, we apprehend, every reason to believe that this nitrous air is the same with the vegetable acids got by fermentation and distillation, from all plants except some of the alcalescent kind ; and from finding that some of those are scarce capable of any sensible degree of acescency by fermentation *, and that in distillation no perceivable acid is got from them †, it is probable, that on trial no nitrous air would be obtained from such plants by Dr. Priestley's method.

* See chap. iii. of this part.

† See Macquer's Chemistry. To analyze vegetable substances which yield the same principles as are obtained from animal matters, instanced in mustard seed.—Vol. ii. chap. vi. process 2.

The experiments we have alluded to are clear, and the proofs we draw from them seem conclusive, and in the strongest manner confirm what we have asserted in the former chapters, *viz.* that vegetable substances, used as food, part with their acid when in the state of chyle, which acid is not only found in animal bodies, but is the corrector of putrefaction in them.

There subsists a very great affinity betwixt the principle of inflammability and the mineral acids, particularly the nitrous; it is therefore probable, that this affinity may be one cause which unites the oils of our bodies with the acid arising from vegetable food, which, in the form of fat, is lodged in different parts, from whence it can be brought into the system as required. It is absorbed, and supplies the place of food when nutriment is wanting, either from disease or necessity; and by its antiseptic

tiseptic powers it corrects putrefaction, or the natural tendency of bodies to a state of dissolution. Were this acid less powerful, there is great reason to suppose from scorbutic cases, that animal bodies would soon run into a putrescent state. This principle seems therefore to regulate the condition of the body: when deficient, it may be supplied by the use of vegetable food; and when a superabundant acescency is prevalent in the system, that may be corrected by animal diet*.

† Dr. Priestley mentions a circumstance worthy of attention, relative to the solution of astringent vegetables in the nitrous acid, such as galls, Peruvian bark, and green tea. They dissolve with peculiar rapidity, and produce one half fixed air, and the other so strongly nitrous, that two measures of common air, and one of this, occupied the space of $2\frac{1}{2}$ measures. May not the powerful effects of astringent vegetables, as antiseptics, be owing to their rapid discharge of these acid airs, which in them may be more loosely combined than in ordinary vegetables; and from this cause also may not their taste of astringency arise, which is something similar to nitrous air combined with water?—See vol. iii. p. 170.

C H A P. IX.

*The Formation of Butter analogous to the
Formation of Fat in Animals.*

IF fresh milk from the cow is churned, and the butter it yields be well washed from the milky parts, and distilled, a strong acid phlegm is got; and when this acid is separated by one or more distillations, the oily part becomes fluid. We have observed, that the butter made immediately from new-milk, however agreeable to the taste, is generally very soft: this we supposed to arise from a deficiency of the acid, as the butter was observed to be much harder when the milk had acquired some degree of acidity by standing, of which the following experiment is a proof.

We took a quantity of new-milk, and having divided it into two equal parts, we
put

put them in two bottles of the same size, to the one of which about a third of its quantity of stale sharp butter-milk was added, and both bottles were shaken, or churned, at the same time: the butter appeared soonest in that which had the sour milk added; and when they were separated and washed, it was also much firmer than the other, and would no doubt have yielded a greater proportion of acid, had both been submitted to distillation.

The newest butter, treated by distillation, yields an acid, which must have existed in the milk before drawn from the animal, as the qualities of milk depend on the properties of the aliments from whence it was extracted.

It is an argument in favour of our opinion, relative to this union being made after mixture with the blood, that the oily

part of the chyle is in a diffused state, and its perfect union only effected after it enters the subclavian vein*. The above circumstance appears also a proof, that when our nutriment is in its progress from the intestines to the subclavian vein, no acid is then mixed with it in a disengaged state, otherwise its union with the oil might be affected in its course through the lacteal vessels.

The action of the blood vessels we conceive to be similar to churning, by which the union of the oils and acids is effected in the body, in the same manner, and by the same causes which unite them when out of it.

* See Dr. Cullen's Physiology, p. 194.

C H A P. X.

Of Fixed Air.

MR. Bewley's experiments, annexed to Dr. Priestley's work, on different kinds of air, prove that mephitic or fixed air either is, or contains an acid *sui generis*, entirely different from all others. The power of this acid air, as an antiseptic, is much less than nitrous air, yet it acts as a corrector of putrefaction in proportion to its acidity*.

Mr. Cruikshank, in the postscript to his letter on absorption, published with Mr. Clare's essay on abscesses, wounds, and ulcers, speaks on the subject of fixed air in the following words :

“ I suspect that it is a particular combination of phlogiston and atmospheric air

* See Dr. Dobson's Medical Commentary on Fixed Air, Sect. 3.

“ which forms fixed air. The experiment
 “ in which the air became fixed by the
 “ burning of phosphorus of urine (the
 “ idea of which was suggested to me by
 “ Dr. Keir) seems to prove this :

“ The phosphorus of urine contains
 “ phlogiston, and a very fixed acid. In
 “ burning, it therefore gives over the purest
 “ phlogiston to the atmosphere. As phlo-
 “ giston, joined to atmospheric air, pro-
 “ duces the same effect on lime-water as
 “ fixed air, I am led to suspect, that fixed
 “ air, however obtained, is a combination
 “ of atmospheric air and phlogiston, or of
 “ something in some respects agreeing with
 “ phlogiston.”

Dr. Crawford, in his Observations on
 Animal Heat, pages 32 and 33, expresses
 himself on this subject in the following
 words :

“ That

“ That the fixed air produced in respiration depends on a change which the atmospheric air undergoes in the lungs is, I think, evident from the following facts:

“ Air is altered in its properties by phlogistic processes, and though many of these processes are totally different from each other, yet the change produced in the air is, in all cases, very nearly the same. It is diminished in bulk; it is rendered incapable of maintaining flame, and of supporting animal life; and, if we except a very few instances where the fixed air is absorbed, it universally occasions a precipitation in lime-water. We have therefore reason to believe, that there is no instance of a phlogistic process in nature which is not accompanied with the production of fixed air.”

Dr.

Dr. Priestley, by taking the electric spark over lime-water, occasioned a precipitation, which not only proves that the air was rendered fixed, but also that electric matter and phlogiston are equally capable of changing atmospherical air to fixed air ; which strengthens the proofs of phlogiston and electric matter being the same, or modifications of the same principle.

Plants depurate air rendered noxious by respiration, great part of which is fixed air. The power of vegetables, in absorbing phlogiston, is now well known ; therefore by their absorbing this principle from the fixed air discharged by expiration, the same air is again fitted for the purposes of animal life ; which shews, that it had been rendered fixed by a union with phlogiston.

We are from the foregoing facts led to suspect, that a part of the fixed air detached

tached from putrid vegetable and animal substances is formed in their pores, and on their surfaces, by the phlogiston which is continually escaping from them uniting with the atmospheric air with which they are in contact; hence the presence of fixed air in these bodies may be less than the quantities they appear to discharge when in a state of putrefaction.

The facility of evolving, or parting with the phlogistic principle, seems to increase in animal matter in proportion as it is further removed from the vegetable state; for we find that the tendency to putrefaction in animal substances keeps exact pace with the degree of their animalization. Hence there is reason to suspect, that the retention of this principle in animal bodies is more strong in proportion as the quantity of acid in them is increased; for acid seems to be the great retainer of this subtile fluid,

by

by the strength of the affinity which subsists between them.

In Chap. III. of the First Part, we have in general considered the air contaminated by respiration, or detached from putrid vegetable and animal substances, as unfitted for respiration by the quantity of phlogiston it contains, reserving for this place a more full proof of the formation of fixed air, by a union of phlogiston and atmospheric air.

C H A P. XI.

Of Vegetable Food of the First Class.

A DIET of vegetables, entirely of the first class, is the most difficult of any to digest and assimilate, not only from their texture, but being furthest removed from the nature of animal matter, by having one at least, if not both of the fermentations

ations previous to putrefaction still unperformed. From these causes they are retained long in the stomach and intestines, before they yield their nutriment to the lacteal vessels. The chyle from them is thin and watery, and much less corroborating in hot than temperate climates.

Those who live wholly on vegetables, even assisted with a cold climate and exercise, are, generally speaking, shorter lived, and in the decline of life fall off much faster than others who have used a proper quantity of animal food*. The same observation holds good in a still higher degree in warm climates; they co-operate with such food, in relaxing and debilitating the body, the juices of which must under those circumstances be poor and thin.

* This observation is made by Sir John Pringle.

C H A P. XII.

Of Vegetable Food of the Second Class.

THE vegetables of this class, as we have already mentioned in Chap. III. may have their alkaline acrimony dissipated by coction ; but even when in this state, they become putrid much sooner than vegetables of the acescent kind. They are however totally incapable of supporting the human body, as the nutriment they yield is very trifling. Their principal utility consists in promoting the digestion of other vegetables in the stomach when used with them. Their stimulating powers when raw assist digestion ; and hence the aromatic and alkaliescent plants are much used in this state by those who live principally on vegetable food,

food, particularly in warm climates. They act in some degree like animal substance, by absorbing the acidity from vegetables of the first class, which accelerates their dissolution. From Sir John Pringle's experiments, the saliva mixed with vegetable aliments, prevent effervescence even out of the body, although the vegetable matters notwithstanding go through the different stages; therefore it is, that in healthful bodies, nourished with a due proportion of animal food, the saliva and stomachic juices prevent eructations; but when animal matter is wanting, the alkaliescent plants are in the same way useful. In weak stomachs, and poor thin habits, eructations from a want of such correctors are common. This effect is produced by a mixture of every kind of animal matter with vegetable food; and the more animalized the matter is, the more powerfully will it act in diminishing effervescence, by
 absorbing

absorbing the acid as soon as formed; and in the same manner do the alcalescent plants act when boiled, by becoming putrid sooner than those of the acscent kind.

C H A P. XIII.

Of Half Animal Food.

THE milk of herbaceous animals we consider as the chyle secreted from the blood, with this difference, that when in the state of milk it is more animalized than when in the lacteal vessels, as it hath undergone an intimate mixture with the blood, previous to its secretion, by which its assimilation when taken as food will be more easy than if used for the same purpose when in the state of chyle*. For

* Omnia fere animalia recens nata lacte nutriuntur; quod partes alibiles, per corporis animalis organa preparatas, continet, et sine ulla masticatione in chylum facile convertitur.

these reasons it becomes a good, quick, and easy digested nutriment, without that difficult and tedious extraction of the chyle, which retards the digestion of vegetable food, though it still retains those acedcent qualities which give vegetables the power of correcting putrefaction*.

C H A P. XIV.

Of Simple Animal Food.

IT hath been already seen what process vegetables go through, in the course of their digestion and assimilation, from which, the cause of their slow conversion into animal substance is readily understood. It now remains to shew, wherein the difference between the digestion and assimi-

* Lac est nutrimenti genus inter vegetabile et animale, ab humano genere universaliter usurpatum, et omni ætate adoptatum.

Dr. Young de Lacte, Pars II. Caput 1. Sect. 1.

tion of simple animal food, and vegetable matters, consists.

Animal substances, from having undergone the two first fermentations, are as far advanced in assimilation when broken down and macerated in the stomach, as the chyle from vegetables of the first class is, when mixed with the blood, after having undergone the discharge of its acid.

From this advanced state of animal matter, its assimilation is easy, and from its texture and solubility, its digestion is also accomplished with little difficulty.

Animal substances have for these reasons effects very different from vegetables ; the latter are antiseptic in proportion to the acid they produce, while the former being past that state, are no longer correctors of putrefaction ; but in animal heat, run directly

rectly into it with considerable rapidity, unless that tendency is counteracted.

It is evident that animal food must be more strengthening than vegetable, as it is made up of the nutritious parts of vegetables only, concentrated and prepared for easy union with living bodies.

Animal substance as a constant food is ill fitted to the human frame: a continued use of it without vegetables must soon end in putrefaction, as the only correctors of its tendency then left, are motion and air; the effects of which last as a corrector of putrefaction in living animal bodies, we shall hereafter shew to be greater or less according to climate.

Animal substance, by being the most strengthening food, becomes its own corrector, by increasing the strength of the solids,

and consequently quickening the motion of the fluids. This to a certain degree is salutary; but if carried further, putrescency brings on relaxation, disease, and death.

The circulation of the blood in herbageous and granivorous animals is moderate and often languid; their tempers are docile, mild, and timid. In carnivorous animals circulation is quick, and their tempers are often violent and fierce, unless when those effects of food are counteracted by climates, either very hot or exceedingly cold, as we shall hereafter mention more fully in the Third Part.

C H A P. XV.

Of Compound Animal Food.

THE digestion of this kind of animal substance is easy and quick. Such animals as live on food of this sort have exceeding little action of stomach.

Fish

Fish are the common food of fish, and their dissolution is easily accomplished by the juices of the stomach, which seem to act as a menstruum.

The facility of digestion, and abundant nutriment which this kind of food affords, is generally considered as the source of that high health, and those numerous families among the inhabitants of the sea-coast.

Vipers swallow their food whole, which are animals, and many of them in some degree carnivorous, such as rats, mice, lizards, &c.; these rest in the body until softened, and melted down by the heat and animal juices. From the nature of their feeding, and this manner of digestion, they stand high in the rank of compound animal food. This species of animal substance is therefore of quick and easy digestion, and the nutriment from it, not only very great, but of ready assimilation.

Common snakes, which feed on herbage, possess none of these qualities in any higher degree than simple animal substance. In cases where much nutriment is wanted in a small volume, and easily digested state, fish and vipers are most proper: the milk of carnivorous animals, which is very near the state of compound animal food, might be found proper also for this purpose.

All the consequences will follow a diet of this kind, in promoting the general tendency to putrefaction, which hath been mentioned as the effect of simple animal food, only in a higher degree, and shorter time, if taken in the same climate in equal quantities, without proper correctors.

The rapid progress to putrefaction in highly animalized bodies arises from a more perfect extinction of all the antiseptic qualities of the vegetables which went to form
the

the original body ; and the further they are removed from that state, the more quickly do they become soft and putrid, and consequently the more easily are the lean parts brought into a digestible state. The oily parts of all animals are most difficult of digestion, and those of the most animalized are the most so, from their greater want of acid ; therefore when fish and vipers are directed for weak habits, the lean only should be used. With such food acids are highly proper, and hence the great propriety of using much butter-milk where fish is the common food.

The flesh of herbaceous animals, such as cattle, sheep, &c. resists putrefaction, under equal circumstances of heat and moisture, longer than the flesh of dogs who have been nourished with animal food. It is well known that the flesh of carrion crows, sea fowls, and fish of all kinds, will be-

come putrid sooner than either of the above animals. Mr. Reaumur has observed that unimpregnated eggs resist putrefaction much longer than impregnated ones : the cause of this difference arises from the semen of the male being a highly animalized matter, and therefore runs sooner into putrefaction, and acts as a ferment, which induces the same through the rest of the egg.

C H A P. XVI.

Of the Intestines.

ANIMALS that feed on herbage have very long intestines, purposely to extract the whole nutriment before the fæces are discharged. Simple carnivorous animals have intestines much shorter, while those which feed on compound animal food, such as fish, have their intestines the shortest of all. On examination, we shall generally

rally find the length of the intestines in different animals, proportioned to the difficulty and slowness with which the chyle is extracted from their food.

By this method of determining the proper food of animals, the human species seem intended by nature for a mixed aliment; and in conclusion it will appear more than probable, that a mixture of animal food in all latitudes is the most salutary, varying in proportion according to climate.

C H A P. XVII.

Of the Solvent Powers of the Stomachic Juices.

THAT the solvent powers of the stomachic and gastric juices are in every animal peculiarly fitted by nature to dissolve and promote the digestion of their particular

particular food, is an opinion which hath lately gained ground : this we shall endeavour to reconcile to our theory of digestion, by shewing how the qualities of the menstrua in the stomachs of different animals, result from the properties of the food they have lived on. The above opinion relative to the solvent powers of menstrua, is founded principally on the following facts :

Carnivorous animals do not digest vegetable aliment so soon as animal food ; and herbaceous animals digest animal food with still greater difficulty.

In answer to the first it must be observed, that the fluids of animals perfectly carnivorous have a strong tendency to putrefaction, which will accelerate the fermentations when mixed with vegetable aliment* ; but it is also to be observed, that the same

* See Sir John Pringle's experiments.

tendency

tendency does at the same time promote the dissolution of animal matter exceedingly, when taken into the stomach; and as this kind of food is nearer to a state of dissolution than vegetables are, its digestion is accomplished before vegetable aliments have undergone the changes necessary to make them yield their nutriment.

In answer to the second argument it must be considered, that the stomachs of herbaceous animals have at all times a strong acidity in them, as the juices they contain are those of vegetables only; and hence it is that when fish or flesh is given to a sheep or other animal perfectly herbaceous, it has been found in the stomach unaffected, while turnip and other vegetable substances given at the same time were dissolved: this results from the acid in the stomach, which on animal matter acts as an antiseptic, but at the same time induces the fermentations

in vegetable food when taken into the stomach.

This is exactly consonant to the experiments of Sir John Pringle, who found that putrid animal matter soon induced the first fermentations when mixed with vegetables, but that the acid produced thereby, was so powerful an antiseptic, as totally to subdue the putrescency in the very animal matter itself, which had actually induced the vegetable fermentations. Hence it may be supposed, that if a piece of tainted animal substance were given to a sheep or cow, it would in a few hours afterwards be found sweetened by the acid of the stomach. We suppose that a Canadian cow, which has been for some time fed on dried fish, would digest animal matter nearly as easily as a carnivorous animal; and that the stomach of a dog, which had been for a considerable time entirely nourished by vegetables, would
preserve

preserve fish or flesh nearly as well as that of an herbaceous animal.

The following case communicated to us by a celebrated practitioner is exactly in point:

A gentleman troubled with stomachic and other complaints, found vegetable food of difficult digestion; a vegetable diet was directed, in which he persevered, and in time found his complaints removed, and the digestion of that kind of food perfectly easy. Having for some years continued a vegetable diet, he thought of returning to the use of animal food; but by the change he found a return of his complaints. This seems to have resulted from a want of that speedy dissolution of the animal matter in the stomach, which would have taken place, had it not been counteracted by the prevalence of the acid that arose from
his

his long continued use of a vegetable diet.

By the above reasoning, it follows that the solvent powers of the animal fluids result not from any particular organization of the bodies themselves, but are the effect of food, and may in the same animal be changed by a continued use of foods of opposite qualities.

C H A P. XVIII.

Of Propensity to particular Foods.

THOSE who live so much on animal food as to have their bodies in a too highly alcalescent state, as it is called (by which is meant a strong tendency to putrefaction), have a great propensity for antiseptics; wines, fruits, and acidulated drinks of all kinds are particularly agreeable to them.

When

When a putrescent tendency is induced by stopped perspiration or otherwise, there is frequently the most ardent desire for powerful antiseptics, which are swallowed with avidity, and often in astonishing quantities. In putrid fevers, many bottles of the most astringent claret are sometimes drank, before the propensity subsides. Of this kind are the longings in the scurvy for acescent vegetables and summer fruits. When this is the case, the thing wished for seldom fails to produce the desired effect.

How such a particular state of the body points out the proper remedies for relief, may we apprehend be in some degree understood, by considering such a state as a derangement or variation from a sound condition of body : in this way a painful sensation is communicated, like that of hunger or thirst, by which sensation the
remedy

remedy may be indicated as much as in the case of hunger and thirst.

When a vegetable diet hath been long used, the fluids are thinned, and the relaxed solids become soft: under such circumstances, the propensity to animal substance is very strong. The oils from animal food, and every part of animal matter, by their putrescent tendency, are fitted to absorb and unite with the superabundant acid*; by which the proportion of this principle is diminished, and the body returned to a sound condition.

In the southern climates this is most remarkable, from the heat co-operating with a continued vegetable diet to relax the solids, and keep the fluids in an uncondensed and ill assimilated state. Persons in this condition eat most greedily of all kinds

* See Sir John Pringle's experiments.

of animal food, not excepting the carnivorous animals themselves, such as dogs, cats, &c. and they generally give a preference to these and tainted animal substance, from an instinctive knowledge, that it will more readily counteract the superabundant acescency of their fluids, than flesh in a sound state*. Such food is harmless and even healthful to those persons, though it would be productive of the worst consequences in bodies that had been nourished by a due proportion of animal matter; as in those, it would increase the alcalescent or putrescent tendency beyond the due bounds consistent with good health†.

The

* Every overseer in the West-Indies knows, that the negroes who cultivate the soil, and live almost entirely on vegetables, prefer salted and tainted meats to those which are fresh and sound.

The poor inhabitants of China, who live principally on rice and other vegetables, are remarkable for eating animal substances of all kinds with great avidity, even when in almost the last stages of putrefaction.

† From this we may observe how the body at some times resists infection, and at others, when in a more animalized state, becomes more susceptible of it.

The inhabitants of some parts of the East-Indies, whose religion forbids the use of animal food, and are therefore confined to milk and vegetables, have not probably these propensities: as they never tasted flesh, therefore they can have no idea of its effect; for it is to be observed, that those propensities are fixed on such things as we are acquainted with the taste of, or are similar in appearance to such things as we know by taste. This, together with the strongest prejudices of education, counteracts in them a propensity so natural to those who are accustomed to the use of animal food, and

Dr. Alexander in his Enquiry says, that from the various animal food used in different countries when in a putrescent state, ‘ one would be tempted to think that there is no difference in aliment, and that the stomach is endowed with ‘ a power of extracting good and wholesome chyle from ‘ every kind of it, in every state in which it can exist.’

This we shall endeavour to prove is by no means the case; and that when such food is harmless, it arises from the general food of the persons being vegetable, or from the particular pure unimpregnated state of the atmosphere in which they live.

have

have no prejudices to conquer; though the same propensity may in some degree be indulged, by the use of alkaline and aromatic plants*.

C H A P. XIX.

Motion a Corrector of Putrefaction.

IN the frigid zone, for the greatest part of the year, animal bodies are in a less putrescent state after death than before it.

This

* Dr. Alexander, in speaking of the proclivity towards putrefaction, ‘ We must, says he, rather judge from the quality of those juices so far as we can discover their qualities; and in forming this judgment, the more crude, watry, and indigested, and the less animalized those juices are, it will, ceteris paribus, be presumable to suppose the animal the more liable to putrid diseases; and this coincides with the observations of several of the best practical authors, who have generally agreed that such people as were debilitated either by former disease, low, poor living, &c. were the most subject to putrid diseases, and the soonest overcome by them.’

This results from the difference of temperature in dead and living animals ; but while animals are alive, motion may undoubtedly be considered a corrector of putrefaction, as by it the circulating fluids are enabled to discharge the putrescent matter which is continually generated in the body.

C H A P. XX.

Effect of Air on living Animal Bodies.

IN the First Part we have endeavoured to point out the different effects of climate and air on vegetables ; we shall now take a view of their influence on animal bodies ; but before we begin, it seems necessary to

These practical observations are just, but they do not admit the above inference ; for it is evident beyond doubt, that the more animalized any body is, the sooner it will run into putrefaction ; yet putrefaction is often induced from debility and want of motion, as we shall hereafter point out in Chap. XXIII.

premise

premise a general idea of the effect of air on animals by respiration.

Among the discharges or excretions from the body, that by the lungs seems least attended to, and hath been frequently considered of little importance as an evacuation. Dr. Keill and Dr. Hales found that a man in twenty-four hours lost by perspiration thirty-one ounces, six of which ounces went off by expiration, and this Dr. Hales says he has found, by certain experiment, to be so much, if not more. A small increase or diminution of this discharge must be attended with evident consequences; and although the diminution of one excretion generally increases another, without inconvenience or uneasiness to the body, yet we apprehend that the excretion from the lungs, cannot in a very great degree be diverted into another channel.

Air is the medium by which the lungs are enabled to make their discharge; but air is capable of receiving only a certain impregnation, and of carrying off but a certain quantity of moisture and putrid efflu-
vium, which quantity depends on the state of its impregnation at the time it is respired. When it is extremely dry and well dephlogisticated, it will carry off a great charge from the lungs; but when it is highly impregnated, it will carry off very little, and if saturated it will not free the lungs at all.

Suffocation is immediately the consequence of respiring air saturated with the phlogistic principle; its effects are exactly the same with a total want of air, as in both cases the lungs get no relief by any discharge.

Dr. Crawford, by his ingenious publication on Animal Heat, has shewn that the
discharge

discharge of the phlogiston by the lungs is necessary to the support of that heat; as this principle is received by the atmospherical air taken into the lungs at each inspiration, from which it precipitates a certain quantity of heat; and the same air which has been deprived of its heat, goes off by expiration charged with phlogiston.

C H A P. XXI.

Theory of the Operation of putrid Effluvium from Marshes.

THROUGH the foregoing chapters we have endeavoured to prove that animal bodies have a strong natural tendency to putrefaction, and would actually run into it, unless prevented by the discharge of their most putrescent parts.

In all animal bodies there is evidently a large proportion of phlogiston; and the more animalized they are, the less fixed is this principle, or in other words, the more abundantly is it evolved.

Dr. Priestley in his third volume on Air, before the publication of Dr. Crawford's Experiments on Animal Heat, had shewn that air inhaled by inspiration received a charge of phlogiston from the blood, which was discharged by expiration. This evacuation to a certain degree is absolutely necessary to the existence of the human species; therefore when the discharge is less copious than the quantity of this principle evolved, it must accumulate and bring on a general tendency to putrefaction. But the accumulation may arise from two different causes, viz. either too much highly animalized food, or an air which is so much impregnated, as not to be able to receive a sufficient

sufficient quantity from the lungs, while perspiration is too limited to make up for this deficiency. Either of these causes will occasion an accumulation, and both will produce the same effects unless corrected.

Dr. Alexander hath given an account of several experiments which prove decisively, that effluvia from marshes act as antiseptics and correctors of putrefaction; from which, he seems to doubt if they operate in inducing putrefaction in living animal bodies. Daily experience contradicts this idea; but to reconcile the antiseptic qualities of the exhalations from putrid marshes on dead animal substance, and their known effects in bringing on a putrescent tendency in living animal bodies, seems difficult, yet the following solution appears probable.

All marshy grounds and stagnated waters emit a smell more or less disagreeable,
from

from the vegetable substances which ferment and rot in them ; this mixture of humidity, fixed air, and putrid vapour, contains a certain degree of phlogiston in this climate* ; but in the warm ones, where these effluvia are most dangerous, they must contain it in a much larger quantity, as putrefaction is there more rapid.

Those vapours impregnate the surrounding atmosphere, and disable it from carrying off from the lungs, the putrid vapour and phlogiston in such abundance as may be necessary to prevent an accumulation in the body ; in consequence of which, putrid diseases come on, not from the matter taken into the body, but from that retained which ought to be expelled, and would actually be so in a purer air. In this seems to consist the great difference between the action of

* See Dr. Priestley on Air from putrid Marshes, in a letter to Sir John Pringle, vol. i. p. 198.

putrid effluvium on dead and living animal bodies; and the same causes which will occasion this retention, may act very differently on dead animal substance, in which there is no continued evolution of the phlogiston until the whole mass of animal matter tends to a state of dissolution.

Dr. Alexander mentions the moisture of the air near such places. This circumstance must have great weight, by moderating the perspiration at a time when it ought to be increased; and from the co-operation of the suppression of this discharge, with that from the lungs, we suppose the disposition to putrefaction is produced; for it is not to be doubted that a free perspiration will give relief, when respiration is laborious; and that an undue discharge of perspiration will affect the lungs by flinging a greater load on them. That particular sorts of deleterious matter must be taken into the
body

body to produce their effects, is undoubted ; such is that of the small-pox, from the air of a room in which there is, or has lately been a patient with the disease. The plague hath also been conveyed to great distances in folds of cloth ; but these are poisons, and some of them so active, from the very high degree of acrimony which they have acquired, as to produce the most immediate effects on the nervous system, independent of their action as septics. These differ widely from the exhalations above mentioned, which arise from vegetables, and are taken into the body in such vast quantities in marshy situations, as would effectually produce the most rapid putrefaction were they in any degree septic.

The airs of the vegetable fermentations which are known to be highly antiseptic, we suppose, mix in such a manner with the
putrid

putrid exhalations as to subdue their effects, and give those antiseptic qualities which Dr. Alexander has shewn them by experiment to possess, when applied to animal matter. The Doctor himself has adopted this idea to account for the consequences of his own experiments, by which he found, that infusions of vegetables in water, and even cabbages and strawberries, after emitting a putrid smell, were still powerful correctors of putrefaction in dead animal matter. The strong antiseptic qualities of the airs discharged by the vegetable fermentations, seem fully to counteract the septic tendency of the putrid effluvium from marshes, when applied to dead animal substance, even should there be small portions of putrid animal matters, in such swampy or marshy grounds; yet these substances will exceedingly contribute to the impregnation of the air, and consequently to its bad effects on living animal bodies, by respiration.

ration, in the manner we have above mentioned.

This appears in a strong point of view, when we consider that fixed air is unfit for the purposes of respiration, though an antiseptic of very considerable efficacy.

C H A P. XXII.

Of putrid Animal Matter taken into the Circulation.

PUTRID animal matter, mixed with the fluids of living animals, gives them a greater or less tendency to putrefaction, in proportion to the degree of putrescency at which it hath arrived; and the more animalised the putrid matter is, the higher degree of acrimony and virulence is it capable of acquiring in the same time.

The following experiments made by Dr. Deidier, with the bile of persons who died of the plague at Marfeilles 1721*, set this matter in a clear point of view.

A drachm of bile, taken from a patient who died of the plague, mixed with water, was injected into the jugular vein of several dogs; they soon became stupified, and died with gangrenous inflammations. Some of the blood of a patient who died of the plague, was put on a wound made on the crural vein of a dog, and covered with a dressing, which the dog got off in the night; he had licked the wound, but gave signs of approaching death towards night. The morning after, he was found dead, and swelled, and the wound also swelled, and gangrened.

* Phil. Transactions abridged, vol. vii. part iii. p. 165
—168.

A dog that followed the surgeons when they went to dress the sick, used greedily to swallow the corrupted glands, and dressings, charged with the pus, which they took off the plague sores; he also licked up the blood spilt on the ground in the infirmary; this he did for three months, yet was always brisk and well. A mixture of one drachm of pestiferous bile with two ounces of water, was injected into the crural vein of this dog; he became dull and stupid, and died like the rest, on the fourth day, with a bubo on the wounded thigh, gangrened. Dr. Deidier adds, that particular notice was taken, that after the injection, while this dog was living, and also when opened after death, he had a very stinking smell, which was not observed in any of the others.

Animals provided with proper secretory vessels for collecting a poisonous juice, are
more

more or less dangerous, in proportion to the quantity of animal food they eat, and time of its stagnation in the organs of secretion. Common snakes, that feed on herbage, are harmless; and however smartly their bite may be felt at the time it is given, the consequences never go further than local inflammation. This is also the case with bees, wasps, &c. whereas the bite of vipers, perfectly carnivorous, is in the highest degree dangerous.

We shall, on examination, find, that the symptoms of, and consequences from, the viper's bite, are the same with the pestiferous bile mentioned in the above experiments.

Animals who live any time after being bit by the viper, turn black, and have all the appearances of approaching mortification; and even those which die in the

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shortest

shortest time, have always gangrenous appearances round the wound *, like those in the experiments made by Dr. Deidier. The rattlesnake is the most dangerous of this tribe ; his first sting is often mortal to dogs in less than one minute ; whereas the succeeding bites are less fatal †, and if the poison is ejected immediately after secreted, it seldom proves mortal. This is a proof that the virulence of their poison is increased by stagnation in its proper receptacles ; but what makes it in the highest degree evident, is, that their bites not only kill one another, but even themselves, when enraged, and made to wound their own bodies. This shews that their poison is in a much higher state of acrimony than the other fluids of their bodies ; and that this difference may depend more on the

* Phil. Transactions abridged, vol. x. page 62.

† Phil. Transactions abridged, vol. vii. part 3. pages 46 and 47.

time of its stagnation, than actual virulence at the time secreted, seems highly probable from what we have just mentioned, viz. that the poison newly secreted seldom kills, but is virulent in proportion to the time of its stagnation.

The matter in Dr. Deidier's experiments, and the poison of the rattlesnake, are also similar in another respect; which is, that both, when taken by the mouth, are innocent. This probably arises from their acrimony being too great to be admitted by the absorbent vessels; and it is therefore most likely, that these poisons pass through the intestinal canal, without being at any time taken into the circulation. Had the dog, who followed the surgeons, actually mixed with his circulating fluids the quantities of putrid matter he seems to have swallowed, it must, we suspect, have brought on, in a very short time, the

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strongest

strongest and most general putrefaction; yet the extraordinary smell from this dog seems to make it appear that he was in a more putrescent state than the others, who had not been accustomed to eat such putrid matter; but it is probable, that this smell proceeded from the intestines, after their motions were deranged by the poison which was injected. No experiments hitherto made, that we know of, have exactly marked the time bodies killed by the bite of a viper take to become putrid, comparatively with another of the same kind, killed at the same time by other means; but from the swelling of such animals very soon after death, and the mortified appearances round the wound, and sometimes general blackness, there is little room to doubt that putrefaction must come on more rapidly in them, than where no such putrid ferment hath been communicated to the body.

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The matter injected by a viper into a wound, must from its extreme acrimony act instantly on the nerves, which is rapidly communicated to the whole system ; for in no other way could such sudden consequences be produced. Its action as a ferment requires more time, and is a very powerful, though a secondary one.

C H A P. XXIII.

Of Vegetable Food in hot Climates.

EXERCISE, and the vegetable correctors of the second class, which, as hath been already observed, act in some degree like animal food, will keep the body tolerably stout in warm climates, as the atmosphere in those climates is more charged with phlogiston than the air of more northern latitudes. It is therefore less capable of promoting a copious discharge by

the lungs, but perspiration is increased to make up for its deficiency; yet notwithstanding the quantity of this discharge by the skin, that very warmth which promotes it, gives the whole body a strong tendency to putrefaction, which corrects the effect of vegetable food, by rendering the animal juices more capable of absorbing the superabundant acid. The digestion of a continued vegetable diet, is by that tendency much promoted; yet in warm climates where animal food is totally wanting, a continued vegetable diet will relax the body so much, that putrefaction frequently follows from a weak and languid circulation. In such cases the smallest wound becomes a sore, and a thin, sharp, acrid, and putrid humour gleans continually from the mouths of the relaxed vessels; tumors are formed by the stagnating fluids, which break and become ulcers; and these continued drains prolong the life, by discharging
the

the putrescent matter, which would otherwise accumulate. This condition of the body from relaxation only, has, we suppose, given rise to the idea of a vegetable scurvy, which implies a kind of contradiction ; but give it what name we will, it is a general putrescent state of the body, though arising from causes exceedingly opposite to that of the true scurvy.

A negro who had been afflicted for several months with ulcers of the above kind, and exceedingly emaciated, was carried into the Plantain walk*, or public garden of the plantation, that he might be abundantly supplied with vegetable food, and live at his ease, which seemed the only means of preserving his life ; this had not the desired effect, for when we saw him he had been there near two months, and became worse than when brought to it. He was now removed from this place, and provid-

* Plantains are a fruit used in the Sugar Colonies for food.

ed with salt beef and salt fish, of which when well boiled he eat three times a day, and was made to move about, and to increase his exercise daily as his strength would permit. We must here observe, that a putrid tendency from the above causes is productive of the same dull, inactive stupor, which are the consequences of the true scurvy ; yet so opposite is it to that disease, that those affected with it have a strong propensity to animal food, and absorbent earths, which they eat with great avidity, from an instinctive knowledge that these will correct the acescent state of their fluids. This patient's ulcers were every day bathed with a strong decoction of bark, to which a little rum was added ; after this they received no other dressing than some powdered bark sprinkled over them. In ten days a visible alteration appeared in his strength and spirits ; his ulcers after this began to look better, in six or seven weeks they were quite filled up, and in less than three

three months were perfectly well, and the negro sound, and fit for easy work. After the first three weeks his desire for animal food diminished greatly, and as he got strength he returned to his former appetite.

We have mentioned this instance, as it was particularly attended to, though all the attempts we have seen made in similar cases, predicted an issue equally favourable; but the want of attention in those climates often frustrates cures which require so much time and care.

It is very common in the Sugar Islands, when a negro falls into this habit, and is much reduced, to send him on board some small coasting vessel, where he generally gets well by being obliged to move about, and having an abundant supply of beef, fish, and other animal food.

C H A P.

C H A P. XXIV.

*Of the Feeding of the Negroes in the
Sugar Colonies.*

IT is unfortunate for the negroes of the sugar islands, that their masters have been so generally impressed with an opinion that animal food is hurtful, and productive of sores ; this has originated from mistaking the sores above mentioned for the true scorbutic ones.

When errors are of long standing, it is exceedingly difficult to eradicate them, particularly in a climate where every mental exertion seems intolerable.

Domestics in the Sugar Colonies eat more animal food than the labourers, and are in consequence much less subject to sores ;
wounds

wounds or scratches on them cure easily ; and they are observed to be more healthful, and live to greater ages, than those who cultivate the soil.

Did the proprietors of estates give a more ample allowance of animal food, their negroes would be more vigorous, and live longer ; for there is not the smallest danger of the real scorbutic sores from an enlargement of this kind.

Fish, as a compound animal substance, is better than an equal weight of beef ; it is a more animalized body ; and therefore a less quantity of it will counteract the effects of a crude vegetable diet.

C H A P. XXV.

Negroes less subject to putrid Epidemics than the White Inhabitants of the Sugar Colonies.

WHEN putrid diseases are prevalent, either from close hot weather, in the latter end of the wet season, or from low marshy situations, the white people suffer exceedingly, and numbers of them are annually carried off with the highest symptoms of putrefaction; but in such seasons, and at such places, the negroes are seldom known to suffer, or be subject to such attacks. This seems evidently the effect of their food; the continued vegetable diet acts as a constant corrector of putrescent tendency*, and prevents the same

* Dr. Lind on the Scurvy. He observes, that Venice, though in a very damp situation, yet the scurvy is there unknown,

same causes from producing the same effects in them, which they occasion on others whose bodies are in a more animalized state.

What proves this in a still stronger manner is, that negro domestics, who live much on animal food, are as subject to putrid epidemics as the white inhabitants.

C H A P. XXVI.

Of Vegetable Food in cold Climates.

THE digestion of a vegetable diet in a cold climate, has less assistance from the putrescent tendency of the body, in proportion as the degree of cold is increased; and the atmosphere of such cli-

known. This he attributes to the heat of the climate elevating the vapours to a great height, or to the great quantities of vegetables eaten by the Italians. Both these causes may operate; but perspiration, and the last, will, doubtless, prevent a tendency to putrefaction.

mates, from the slow progress of putrefaction in them, is less impregnated or phlogisticated in the same proportion. The human constitution is such, that different causes produce on it the same effect, and different climates produce these different causes, which counteract their improper influence.

The less tendency the atmosphere of any climate has to promote putrefaction, the greater is the degree of cold in that climate, which in proportion braces and strengthens the body. This vigour accomplishes, in the digestion of vegetable food, what an impregnated atmosphere, and stronger putrescent tendency of the body, does in warm climates; and hence, in cold regions, an entire vegetable diet is not so injurious to the strength, as in the warm ones.

In the cold, although the food may not be assimilated in much shorter time, yet the
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the climate counteracts its relaxing tendency, by strengthening muscular force, and quickening the motion of the fluids; whereas, in the warm latitudes, from the want of this natural and powerful corrector, a loose texture of the solids, thin fluids, and languid circulation, are the consequences.

C H A P. XXVII.

Of Animal Food in hot Climates.

A DIET entirely animal, between the tropics, is productive of the opposite effects from that of a vegetable one. The heat and state of the atmosphere co-operate to promote and quicken the dissolution of such food, which, by its abundant nourishment, and speedy animalization, counteracts the relaxing tendency of the climate, and gives strength to the whole frame. Such a
condition

condition of body is certainly the most desirable, were it not the most dangerous; under such circumstances of food, the whole body is in a high animalized state, and consequently, in such climates, under a strong tendency to putrefaction. When obstructions happen, which prevent the excretions in their due proportions, the body soon acquires, from its animalized condition, a putrescent tendency that is speedily increased by the heat, and the impregnated state of the atmosphere; which, as we have already shewn, renders it unable to absorb a due proportion of phlogiston from the lungs.

C H A P. XXVIII.

Of Animal Food in temperate and cold Climates.

IF a body is supported entirely by animal food in temperate climates, it will produce the same effect as in the warm ones, but

but not in so short a time, as neither the impregnation nor temperature of the atmosphere are fitted to favour putrefaction ; and although the cold co-operates with the food in giving density to the fluids, by strengthening the solids, yet the same cold and food quicken motion, and the first unites with the depurated state of the atmosphere to prevent the progress of putrefaction, by enabling the lungs to make a more abundant discharge of the phlogistic principle. When we remove further north, a diet of the same kind is still more counteracted by the unimpregnated state of the atmosphere, and the powers of cold as an antiseptic ; and in consequence, the effect of a continued animal diet is longer resisted in the latitude of 60 than 40. When we go still further north, and take a view of the inhabitants of Lapland, Groenland, and Nova Zembla, whose food is entirely animal, and in the two last places

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fish

fish only, we shall be sensible of the effects of a depurated atmosphere, in counteracting the tendency of such food, by promoting a copious discharge of putrescent or phlogisticated matter from the lungs, on which the accumulation takes place, from an almost total want of perspiration.

These are strong and undoubted proofs, that a dense dephlogisticated air may so promote the discharge by the lungs, as to make it equivalent to the deficiency by perspiration.

We have already mentioned, that Dr. Keill and Dr. Hales determined the discharge by the lungs in this country to be six ounces out of thirty-one, which is rather less than one fifth part; if therefore we take this as a medium, we may suppose in the hot latitudes, that this discharge by the lungs is to that by the skin, as a seventh
part

part of the whole only; whereas at Groenland it may be a third part of the whole, or perhaps at Zembla one half of the whole. This supposes the same body under the same circumstances of food in all the three places. There is every reason to suppose these variations very great, as Dr. Priestley hath shewn, that pure air is five times less phlogisticated than atmospherical air in this climate; and we know that common air can admit a much greater charge, as well as greater degree of depuration.

From what has been said above, it is evident that every expiration at Groenland or Nova Zembla carries off a much greater quantity of putrid effluvium or phlogiston, than an expiration between the tropics is capable of doing, where the air is not only dilated by the heat, but greatly impregnated.

The inhabitants of these northern climates are generally afflicted with scurvy, and it is observed that the natives have the most disagreeable foetid breaths * ; and that their urine, when kept, smells most intolerably †.

C H A P. XXIX.

Of Diseases peculiar to hot Climates.

RELAXATION of body may be considered as a certain degree of putrescent tendency, which tendency seems the cause of almost all the endemic diseases of the torrid zone. We have already particularised that species of putrescency which arises from debility, and which takes place in warm climates from a crude vegetable diet.

* Harris's Collection of Voyages. Journals of the North Sea Company of Copenhagen.

† Same Book. Mr. John Egede, a Danish Missioner, his Account of the Inhabitants of Groenland.

Scorbutic habits, rather than scurvies, are also frequent from a too much animalized state of the body, and an impregnated atmosphere. Diarrhœas and dysenteries, from crude vegetable food and relaxation, are also very common. Putrid fevers from suppressed perspiration, and an impregnated atmosphere *, are exceedingly general ; by which the matter that should be discharged from the skin and lungs is retained, and these operate rapidly from the circumstances of climate.

Nervous diseases are also the effect of relaxation, consequently frequent in warm countries. The disagreeable, and often highly putrid smell of the discharge from blisters in this disease, proves the putrescent tendency of the humours.

* See Chap. XXI. of this Part.

The tetanus, or locked jaw, from slight wounds, is most common between the tropics, and arises from an exceeding irritable state of the nerves *. Nothing can more strongly prove this, than observing what people are most subject to it. There is scarce an instance of a white man falling a sacrifice to this disease, but such as have been reduced to a low and very relaxed state by long sickness, or excessive debauchery. Even negro domestics are very rarely attacked with it; while it is common among the labourers, and almost without exception fatal. The reasons of this obviously arise from their way of living, which we have already mentioned in Chap. XXIII, XXIV, and XXV.

* That atony and spasm can subsist at the same time in the same vessels, Doctor Cullen in his First Lines considers as undoubted.

C H A P. XXX.

Diseases peculiar to very cold Climates.

THE endemic diseases of the frigid zone arise from an over-tense fibre in consequence of too great a degree of cold. A general tendency to putrefaction, from a too high animalized state of the body, resulting from food and want of perspiration, is also most common, notwithstanding the dephlogisticated state of the air which the inhabitants breathe. What would be the effect of a continued vegetable diet, to an inhabitant of Nova Zembla, is difficult to say; but it seems probable that a putrescent tendency may there be absolutely necessary to support animal heat and motion.

This appears in a stronger point of view when we consider, that by Dr. Crawford's

theory of animal heat it is proved, that bodies lose their sensible heat more quickly in proportion as the atmosphere they are in is colder. Hence in very cold climates a larger proportion of heat must be precipitated from the air taken into the lungs, to make up for the continual expence of heat from the surface of the body : but the quantity of absolute or latent heat in atmospheric air, depends on the purity of that air; and to precipitate and render that heat sensible, depends on the quantity of phlogiston furnished to make the decomposition in the lungs. Hence a putrescent tendency of body, which admits a copious evolution of the phlogistic principle, seems necessary to procure a sufficient decomposition of heat from the atmospheric air in the lungs, to keep up the temperature of the body. Facts verify this doctrine; for the air of all climates is found more dephlogisticated in proportion as they become colder; while the atmosphere of the tropical latitudes, by being more phlogisticated,

cated, contains less heat, and consequently is less capable of increasing the heat of the blood in the lungs. A great precipitation of heat from atmospherical air is less necessary in those climates, as the expence of sensible heat from the surface of the body, is infinitely less than in northern regions. It therefore seems probable, that the supply of heat which takes place in the lungs, is regulated by the loss of heat from the surface of the body, as the atmospheres of different countries are phlogisticated in proportion to the warmth of these countries, and according to the degree of that warmth do they absorb the heat more or less rapidly from the surface of the body; hence, in hot climates, where the latent heat of the atmosphere is small, the decomposition in the lungs will be moderate, and the loss of heat from the surface of the body be diminished in the same proportion. In this way we suppose the universal equality of human heat in all climates may be accounted for.

Thus

Thus an habitual putrescent state of the human body seems necessary in very cold climates, as it affords the natural and most effectual means of correcting their influence, and supporting the proper degree of heat necessary to life.

C H A P. XXXI.

Of the Diseases of the Middle or Temperate Climates.

OVER this district of the globe, which we suppose to extend from the 30th to the 65th degree of latitude on each hemisphere of the earth, there is, generally speaking, scarce any disease, or class of diseases, which can be called endemics, as in no part do we find those causes existing with sufficient influence, which determine the diseases of the torrid and frigid zones*; but
in

* Baron de Montesquieu makes an observation similar to this, relative to the genius of the nations of the middle climates :

‘ Dans les pays tempérés vous verrez des peuples inconstans
‘ flans

in consequence of this want of force to give a general character, we find, in the temperate climates, the diseases of both the hot and cold latitudes mixed together under a vast variety of forms, multiplied by innumerable causes which depend on situations, seasons, population, woods, morasses, and the state of cultivation. From these and other similar natural causes, arise the variety of diseases which are found in the temperate climates, while those of the torrid and frigid zones are few, and generally uncomplicated.

C H A P. XXXII.

Of being habituated to Climate.

WHEN Europeans arrive in the hot latitudes, their bodies are not for some time sufficiently relaxed to discharge their perspiration freely : hence arises what

‘ flans dans leurs manieres, dans leurs vices mêmes et dans
 ‘ leurs vertus ; le climat n’y a pas une qualité assez deter-
 ‘ minée pour les fixer eux-mêmes.’

De l’Esprit des Loix, Tome ii. Chap. 11.

is called the seasoning, which is an inflammatory fever.

The great evacuation the patients suffer in the course of their cure, relaxes the vessels, and perspiration becomes thereafter free and easy; this is the change or degree of relaxation meant by seasoning, or being habituated to the hot climates.

Similar effects will follow to persons going from hot or temperate climates to Groenland or Nova Zembla. The perspiration to which the body has been accustomed is prevented by the cold, and the force of circulation hath not yet dilated the vessels of the lungs, to let them discharge so plentifully as those of the natives, the rigidity of whose solids forces a strong circulation, by which a copious discharge is made. Strangers are therefore more subject to the scurvy than the natives,
and

and are more so the first winter than afterwards, when they become seasoned, or habituated to the climate by the dilatation, of the vessels of the lungs ; and these vessels are kept in that state, or rather still dilating, by the quantities they are forced to discharge.

C H A P. XXXIII.

Of the Lunar Influence on Animal Bodies between the Tropics.

WE have in the First Part endeavoured to point out the influence of the moon in promoting the circulation of the vegetable kingdom, by her attraction, elevating and diminishing the perpendicular pressure of the atmosphere. We shall now take notice of her influence on diseased and weak habits in the tropical climates.

In

In the equatorial latitudes, people of delicate constitutions, either from nature or disease, are exceedingly sensible of the lunar influence at change and full; and those who are in any degree afflicted with that species of madness called lunacy, have their fits more violent than in northern climates*. If debilitated persons are attacked with intermittent fevers, they find it very difficult to avoid a relapse or return of the fever at new and full moon. This fact is so well known in those climates, that such people generally take a certain quantity of bark each day, for several days before each change and full; which commonly pre-

* Mr. Griffith Hughes, in his Natural History of Barbadoes, makes this observation: ' Nor is it less improper (says he, meaning the climate) to persons who labour under any degree of phrensy or madness, whose periodical fits, at the full and change of the moon, return here with greater violence than in a cold climate.'

vents a return of the disease, unless the patient is exceedingly weak, and unable to contribute to the tonic powers of the bark, by riding or other gentle exercise.

These effects of the moon's position seem to result from the diminished weight of the atmosphere, by her increased attraction when in the particular situations of full and change; by which a part of the external pressure is gently removed, and the body allowed to dilate itself; a debility of the whole system is the natural consequence of such dilatation, and to correct this effect, the powers of the bark as a tonic are generally found sufficient.

The action of the bark, at this time, hath been by many (particularly the French practitioners) attributed to its antiseptic qualities, from an idea that those returns

are occasioned by the atmosphere being at these times remarkably impregnated with putrid exhalations, produced by the power of the moon in promoting putrefaction.

Whatever effect this might be supposed to have at the full, it can have none at the change of the moon, as the contact of the lunar rays only seems to produce this effect, and the relapses above mentioned are as common at the change as at the full*.

The cold bath is generally found as effectual as bark in preventing the returns of fever at new and full moon, from which we suppose that any tonic of equal power would produce the same effect.

* There are instances of particular people, who from some delicacy of constitution have most violent head-achs if they stand a quarter of an hour uncovered and exposed to the full moon.

C H A P. XXXIV.

Of the Scurvy.

THIS disease may be deemed a general tendency to putrefaction, from a want of a sufficient proportion of the vegetable antiseptic acid, or a superabundant alcalescency, which is in fact the same thing. This deficiency may arise from both the causes we have mentioned in a former chapter, viz. either an overabundant quantity of animal food, or a suppression of the proper discharges of the body, by which the putrescent matter is retained, and accumulates.

Although these causes are evidently different, yet they produce the same disease, and their effects are the same, when in an

O equal

equal degree. The tropical scurvies are different from those of the north in degree only; yet we shall consider them separately, that we may be more easily understood.

CH A P. XXXV.

Of the Scorbutic Tendency of warm Climates.

IT is a fact well established, that summer fruits and green acedcent vegetables are sure remedies in this disease, provided the proper discharges from the body are free and regular; of all which, perspiration by the skin and lungs is of the greatest consequence. Where these are copious, the scurvy can never rise to a great height; and from this cause alone, the disease in the tropical latitudes seldom runs beyond what may be called a scorbutic tendency, rather than a confirmed scurvy.

In

In these latitudes the discharge by the lungs is, from the impregnated state of the atmosphere, more moderate than in colder climates; and did not the abundant perspiration by the skin make up for this defect, scurvies would there rage with their greatest violence. From this effect of perspiration, we may observe of what consequence it is, either in preventing this disease or promoting its cure. The acescent fruits and other vegetables, which are to be found every where in these climates, afford the most effectual remedies, and the particular propensities of the diseased abundantly point out to them their utility. From the frequency of these remedies, and the free perspiration in those climates, one might be led to suppose that even a scorbutic tendency would rarely happen; but the case is far otherwise.

The inhabitants in easy circumstances are seldom troubled with these complaints,

unless they live much on flesh and fish, and take little exercise to promote perspiration ; yet from these causes, among even them, we have seen this tendency so great as to give putrid gums, and sores on the face, legs, and hands, together with a rough dry skin, all of which were removed by a change of diet, exercise, and free perspiration.

Those who are the most afflicted with this disease in hot climates, are tradesmen, low overseers, and sailors, who from their employments are exposed to the moist damp air of the evenings and nights, which in low and wet inland situations greatly obstruct the perspiration, particularly in the rainy season ; and the same damp air being ill fitted to promote the discharge by the lungs, the retained putrescent matter accumulates, and soon gives this general tendency to the body. To these sources of this disease we may add the salt beef, which

which is almost their constant food. These united causes, notwithstanding the vegetables of the climate, are often found to induce a considerable degree of scurvy. Old wounds break out, and new scratches soon become ulcers, which discharge abundantly. When this is the case, those drains retard the progress of the disease, by preventing an accumulation of the putrescent matter, though they exhaust the body by their continued discharge.

We have known sores of this kind existing for ten or twelve years ; during which time the persons enjoyed good health otherwise, and we have been told of many of much longer standing.

When these sores discharge plentifully, the gums, which are generally affected, get well, and the appearances of scurvy go off ; but a stoppage of them by violent styptics

O 3 (which

(which we have known done) often proves fatal, unless the general diathesis of the body is altered by a long continuance of an antiseptic regimen, and change of situation, to one where the patient may breathe a more dry air, and perspiration be encouraged to flow most freely. Under these circumstances they often cure of themselves, with little or no dressing. Those ulcers become a kind of new outlet, or artificial drain, by which the putrescent and phlogisticated matter of the body is discharged, when the state of the atmosphere and interrupted perspiration are unable to free it sufficiently fast to prevent an accumulation. A sudden stoppage of these discharges often affects the breast, and consumptions sometimes follow; but if large ulcers, which discharge plentifully, are injudiciously stopped, the consequence is frequently a putrid fever, with all the symptoms of this disease peculiar to hot climates.

CHAP. XXXVI.

Of the Scurvy of the North.

FROM the foregoing chapters, it is obvious that obstructed perspiration will bring on the scurvy, let it proceed from whatever cause it may. In the temperate climates this obstruction generally arises from moisture, which not only prevents perspiration by the skin, but clogs the air, and renders it unfit to carry off a due proportion of putrescent matter from the lungs. As a proof of this, we may have recourse to Dr. Lind's treatise on the scurvy; he has given many instances, where a moist atmosphere, conjoined with a very moderate degree of cold either at sea or land, have been productive of scurvy. And why seamen in long voyages are more

subject to it than men at land, the same author makes clearly to arise from their being more exposed to these causes, together with a greater want of proper vegetable correctors.

From what that gentleman hath said, it is evident that sea air does not dispose the body to a scorbutic tendency ; and we are for the following reasons of opinion, that it rather counteracts a putrid diathesis.

Agitation with water will depurate phlogisticated air ; and the more any air is freed from its phlogiston, the greater load it will carry off from the lungs, and the longer it will support animal life*.

We

* Dr. Priestley says, ‘ Since, however, water in these Experiments must have imbibed and retained a certain proportion of the noxious effluvia, before they could be transmitted to the external air, I do not think it improbable but that the agitation of the sea and large lakes may
‘ be

We are therefore led to suppose, that the sea air is more dephlogisticated than that of the land. This opinion is much confirmed by an observation made by most writers on the scurvy; which is, that this disease rages most in narrow seas, and channel cruises, and in ships stationed on coasts. Some cause must produce this difference, and it seems no other than the very moist and impregnated state of the air in such situations, both of which are the effects of vicinity to the land.

From this view of the causes of scurvy, people on shore are protected from it more effectually than those at sea, by the conveniences of life and vegetable food. Were these wanting, and the personal exposure

- ‘ be of some use for the purification of the atmosphere; and
- ‘ the putrid matter contained in water may be imbibed by
- ‘ aquatic plants, or be deposited in some other manner.’

Priestley on Air, vol. i. page 98.

equally

equally great and frequent, there is little doubt but it would be as violent on land as at sea.

When we remove further north, where the air is more clear and dry, the cold increases in proportion, and effectually stops the pores, and prevents a discharge of the putrescent matter by the skin; but in these places the purity and density of the atmosphere enable the lungs to make most copious discharges; and by this evacuation, together with the antiseptic powers of the cold, notwithstanding the high animalized diet of the inhabitants, the scurvy seldom runs to such heights among the natives, as it often does on board of King's ships in more temperate climates, where the obstructions arise from moisture*. In both cases, whether

* Sir John Pringle, by his experiments on common salt, makes it to be in small quantities rather a septic, than otherwise, when taken into the body, or in warm mixtures when
out

whether the perspiration is stopped by moisture or cold, or both, the effects are the same, unless relieved through the lungs; and this discharge, as we have already observed, varies in quantity according to climate.

out of it. This seems to account for salt provisions giving a septic tendency more readily than the same meats when eaten fresh. It also affords an explanation of its effects when given to herbacious animals. If they are emaciated and unable to digest their food, a mixture of salt (which they are exceedingly fond of, when troubled with indigestion) gives them a fresh appetite, by acting as a stimulus in the first place, while in the second place, by promoting the dissolution of their food, the extraction of the chyle must be facilitated.

It hath been suggested by Dr. Cullen, that this effect of common salt probably arises from some impurities of the absorbent kind mixed with it, which is the case unless particular pains be taken to purify it. But even should these effects arise from such impurities, as they are general in common salt, the use of it will still be productive of those consequences, in both carnivorous and herbacious animals.

C H A P.

C H A P. XXXVII.

Of a Diet to prevent the Scurvy at Sea.

FROM the foregoing observations and theories, a constant and regular supply of vegetable antiseptics, which produce proper acids by their fermentations, are not only necessary; but a due evacuation by perspiration must be kept up, to prevent an accumulation of the putrid matter generated in the body. The methods in practice at sea are much more directed to answer the first indication of cure than the second; but experience makes it evident, that without accomplishing both in a certain degree, it is impossible to prevent the scurvy. Dr. Lind says, that sweat is an evacuation from which scorbutic patients find the greatest benefit, and he therefore advises antimonials, aromatics, and warm baths.

Dr.

Dr. M'Bride advises warm clothing; and could his advice be followed in this particular, it would doubtless produce the best effects. The wort recommended by this gentleman had a favourable appearance, but on trial hath not been found to answer the end proposed*. It is calculated to answer the first indication of cure, but will not accomplish the second, which is as necessary as the first, and must be at least equally attended to, or every attempt will prove unsuccessful. A kind of beer recommended by Dr. Sylvester, composed of crude tartar, juniper berries, orange peel, ginger, cloves, and sugar, seems to have been much more effectual than the wort†.

It

* These trials were made by Mr. John Clark, Surgeon to the Talbot Indiaman.—See his Observations.

† Trials with this also made by the same gentleman, Mr. Clark. See his Observations.

Mr. Patten, Surgeon to the Resolution, commanded by our great circumnavigator Capt. Cook, has a more favourable

It hath generally been found, that the *alcalescent* and *aromatic* plants contribute exceedingly to the cure of the *scurvy* ; it is evident that this effect cannot arise from *antiseptic* qualities, as those plants yield exceeding little of the *vinous* or *acetous* principle, and many of them so very little as scarce to be discovered by any process whatever. (See Chap. III. and VIII. of this Part) These effects seem therefore to result from their *penetrating*, *warming*, *diuretic*, and *fudorific* qualities, by which they promote a very free *perspiration* from the surface of the body, and a copious discharge by urine.

able opinion of the wort, as per extract from his Journal (See Sir John Pringle's Discourse on preserving the Health of Mariners, delivered at the Royal Society, Nov. 30, 1776). The great attention paid by Capt. Cook to his people, their warm clothing, and being only one third of their time on duty instead of one half, which is common ; were most powerful assistants to the wort, by tending to keep up that perspiration which seems so necessary to prevent the *scurvy*.

These

These evacuations carry off the putrescent matter, which would otherwise accumulate ; and in this way, we apprehend, they do service in scurvies, and not as antiseptics, from the volatile alkaline salt they contain.

Perpiration in the warm climates is found to prevent scurvies, notwithstanding an animal diet and high impregnated atmosphere ; and if our opinion is well founded relative to the action of the second class, viz. the alcalescent and aromatic plants, we shall find that a due mixture of these vegetables with those of the first class, will produce the end wished for, as it seems natural to suppose, that a much less degree of perspiration, procured by these means in a cold country, will prevent the scurvy, than what might be necessary in the hot latitudes, where the climate is so very favourable to putrefaction. The opinion of Dr. Lind favours this idea very much ; and the

success of Dr. Sylvester's beer, in the experiments made by Mr. Clark, is also a presumption in its favour. We are therefore led to suppose, that a large mixture of the alcalescent and aromatic plants, preserved raw in vinegar or wine, and made a part of the daily food of seamen, would in a great measure keep up the necessary perspiration, particularly if warm clothing is joined, and both are added to the preservatives of the acescent kind now used. Large quantities of mustard, horse-radish, garlic, and shallots, together with pounded ginger, may be steeped in any cheap white wine, and the daily allowance of this given instead of the rum now in use.

Mustard should be freely used, and an abundant supply of horse-radish, garlic, and onions preserved raw in vinegar, should be eaten with all kinds of solid food.

These

These ingredients are simple, their preparations easy, and may with little expence be made at all times before a voyage begins, in sufficient quantities to serve through the course of the longest, without losing their qualities.

Those preparations added to the food of seamen, and abundantly supplied where the situations are either cold, or damp, or both, together with spruce beer, with which may be fermented some ginger, and the chips or raspings of guaiacum-wood, will make a most agreeable liquor for common drink, which we apprehend is well fitted to correct a putrescent tendency by its action to both, as an antiseptic and sudorific.

These simples used in the extent proposed, must, we imagine, answer both indications of cure, and also supersede the

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use

use of spirituous liquors, so generally thought necessary by seamen in cold wet weather.

C H A P. XXXVIII.

Of Phthisis Pulmonalis, or Consumption of the Lungs, as consequential to Climate.

THIS disease is evidently a putrid one, though more properly belonging to the temperate regions, than either to the torrid or frigid zones. It generally originates from inflammatory disorders, such as coughs, peripneumonies, &c.; and although a degree of inflammation may accompany the phthisis through all its stages, yet it is here to be considered as a chronic disease of the putrid kind, as the degrees of inflammation which attend it in its formed state, are rather consequences than causes of the malady. Dr. Alexander says, that a
piece

piece of meat putrifies sooner, that has been breathed upon by a person with diseased lungs, and a bad breath, than another of the same weight that has been breathed upon for the same time by a sound person *. This is a very full proof that the disease is not only putrid, but that a part of the putrid matter is discharged with the air by expiration, which acts as a ferment on the meat with which it comes in contact.

In the warm climates, a septic tendency of the body makes its appearance under the different forms of putrid fevers, diarrhœas, or scorbutic habits. In the far northern latitudes, the diseases of the lungs are the consequence of scurvy; there, during the winter season, from the almost total want of perspiration, an over-quantity of phlogisticated matter is thrown on the lungs,

* Alexander's Enquiry, page 48.

which they are not able to discharge so quickly (notwithstanding the purity and density of a northern atmosphere), as to be unaffected by it. In the torrid zone, an accumulation of putrescent matter is rapidly increased by the heat, and operates most speedily, unless discharged by ulcers, profuse sweats, or sudden diarrhœas.

In the middle climates, the colds are not sufficiently great to stop the perspiration so effectually as to produce scurvies, while by a diminution of it, an over-proportion of moisture and phlogisticated matter is cast on the lungs, which the more impregnated atmosphere of the middle climates is less able to carry off, than the dense depurated air of the frigid zone; and when perspiration is deficient here, the pressure for discharge by the lungs is increased, which brings on inflammation, hæmoptisis, &c.

From

From this concentration of the putrescent or phlogisticated matter of the body towards the lungs, as the most natural outlet when perspiration is diminished, arises, we apprehend, that clear and pellucid skin, so peculiar to those who are consumptively inclined, and even continues to the last in those whose disease is solely confined to the lungs. When the putrescent tendency diffuses itself through the whole body, it is then a certain degree of scurvy; and in such cases the skin becomes dark and tawny, which is the constant attendant of a general putrescency, as will be more fully mentioned in Part the Third.

C H A P. XXXIX.

Places most productive of Consumptions.

LOW, damp situations prevent a free discharge by the skin, and if the flats are extensive and very much inclosed, the

P 3 atmosphere

atmosphere becomes more impregnated with moisture, which not only obstructs perspiration, but renders the air less able to free the lungs by expiration. For we must here observe, that air is capable of a certain saturation with moisture as well as phlogiston; and when the degree of its impregnation with humidity is considerable, the necessary discharge of moisture from the lungs is impeded in proportion, and the discharge of this vapour is as necessary to free respiration, as that of the phlogistic principle. It is in this way, we apprehend, that air, by a load of moisture, is unfitted for free respiration *, and will even extinguish a candle †.

There are instances of particular places and towns, the inhabitants of which, from

* Air, impregnated with the vapour of pure water, threw a bird into great anxiety. See Dictionary of Chemistry on Gases, page 16.

† See Priestley's Miscellaneous Observations, vol. i. page 159.

being

being free of these diseases, have become, in the course of thirty or forty years, exceedingly subject to them. The increase of such towns, the greater quantity of animal food eaten, and the less exercise taken, together with the surrounding country becoming much inclosed, particularly if the climate is moist, and the soil abounding with clay (which retains the rain on its surface, by preventing filtration into the earth); all these causes tend to promote putrefaction in living animal bodies, by impregnating the air with humidity, which renders it unable to give relief by the lungs, when a more than ordinary discharge is required in consequence of diminished perspiration, which is always an attendant of a humid atmosphere. While the body is in good health, and in a proper climate, a diminution in the quantity of any one excretion is made up by the increase of others, on which nature flings the load to

be discharged ; but when climate (on which depends the state of the atmosphere) is unable to assist, or counteracts the efforts of nature, by preventing that copious discharge which is necessary, by one excretion, to make up for the deficiency of another, disease must be the consequence, as in consumptions.

This malady, then, before tubercles or ulcers are formed, seems not to be a general increased evolution of putrescent matter, as in the scurvy, but the discharge of the natural quantity too copiously directed towards the lungs, by the diminution of perspiration ; in consequence of which obstructions and inflammations come on, which are followed by the true phthisis pulmonalis, or consumption of the lungs*.

* This disease may be hereditary, we suppose, by a peculiar texture of skin, ill fitted to discharge perspiration freely. It may also be so, from mal-conformation of the thorax.

Hippocrates says, this disease happens principally from the age of eighteen to thirty-five; but there are not wanting instances of it, both before and after these periods, though from the vigour of that time of life, a phlogistic diathesis is doubtless vastly more common and dangerous.

C H A P. XL.

Of the Cure of Consumptions.

FROM what we have pointed out as the cause of this disease, the cure is to be accomplished by restoring a free perspiration, and breathing a pure dephlogisticated air, together with proper evacuations, and antiphlogistic food and medicine to diminish the putrescent tendency as much as possible. Warm clothing, with gentle exercise, or riding on horseback, joined

joined to a vegetable and milk diet, often produce the best effects; but when the disease does not yield to these means, a copious discharge by issues is often of the greatest service.

From the sudden effect which old ulcers, injudiciously stopped by violent styptic medicines, have on the lungs, it seems probable that artificial ones brought on the legs by caustics, or actual burning, and encouraged to flow most freely, would bring relief to the lungs, and through them, that phlogistic matter be evacuated, which the lungs are unable to discharge.

We have seen ulcers stopped, which soon affected the breast; but the discharge being again brought on, the lungs were relieved, and the patient remained in his former health.

When

When all these methods prove ineffectual, and the putrid matter can neither be corrected, nor diverted into another channel, a sea-voyage to the southward frequently proves a cure, if the disease was not too far advanced before this remedy is attempted. In going to the southward, the pores of the body are opened, and the depurated state of the sea air enables the lungs to fling off the phlogiston with which they are overcharged. Besides the purification of sea air, from passing along the surface of an extended ocean, it is also much impregnated with saline matter, which, together with its depuration, renders it so exceedingly unfavourable to vegetable, and so very salutary to animal life, particularly in cases of a putrescent tendency which affect the lungs. The existence of this saline matter in sea air is indubitably proved by the great difficulty there is to keep iron from rust, not only at sea, but in every place

where the sea air pervades, and in warm climates this is still more observable. On ship-board, a cloth washed with fresh water, and dried, is perfectly tasteless when chewed; but if hung up exposed to the wind, it acquires a strong saline taste; this experiment we have often made. These saline particles must be antiseptic, which being applied to the lungs with the very air itself, at every inspiration, will counteract the progress of putrefaction, at the same time that a larger proportion of phlogisticated matter is discharged by each expiration at sea than at land, and thus sea air acts beneficially in a double capacity.

It is a very general idea in this part of the world, that the climate of the torrid zone is favourable to consumptive people; but experience proves the opinion not generally just, for not one in ten recover if
they

they remain on land ; as the too warm impregnated state of the tropical atmosphere, is exceedingly unfavourable to these complaints ; but if the patient keeps very much at sea, and has the benefit of both its air, and free perspiration from the warmth, his chance, if supplied with proper food and medicine, and a roomy vessel, in which he can get a little exercise, is the best he can have *.

The most favourable situations for the residence of persons afflicted with these complaints, are near the sea, in a dry and moderately warm climate, situated between the latitude of 36 to 45 degrees ; in such places, the air is at no time so much impregnated with the phlogistic principle, as between

* We have known an instance, where a person soon got well at sea, but by residing at land, the complaints returned, and on going to sea, were again removed.

the tropics, though nearly as much charged with saline vapour by contact with the surface of the sea, while the warm dry weather in such a climate is sufficient to keep up a proper discharge from the surface of the body.

If the air of a chamber could, by artificial means, be so mixed with pure dephlogisticated air, as to render it greatly better than common air; perhaps (by keeping it in a state of depuration comparatively with that of dephlogisticated air, as one to three, or one to two, instead of the common state of atmospherical air, which is one to five), we should be able effectually to discharge by the lungs the phlogistic accumulation, while the general state of the body might be corrected by proper antiphlogistic and antiseptic methods, so as to prevent, if kept in that condition, the risk of accumulation

lation from the future use of common atmospheric air*.

C H A P. XLI.

Of the Small Pox.

THE success of the new and cool method of treating this disease, evidently proves it of the putrid kind. When the patients are of a full habit, and have lived freely, this disease in all its stages is most violent, as such a state of the body disposes it exceedingly to putrefaction; consequently a foreign matter introduced into the blood, which of itself is sufficient to dispose the most mild fluids to putrefaction, must operate with increased violence on such as have already too great a tendency that way.

* The ingenious Dr. Priestley was not only the discoverer of dephlogisticated air, but gave the first hint with respect to its utility in respiration, vol. iii. p. 85.

From

From this reasoning we may easily see the great advantages which attend a proper preparation by food and medicine; all animal matter must be avoided, and spirituous liquors of every kind; in short, the nearer the body is brought to the state of simple animal substance, the less dangerous will this disease be, as it will more strongly counteract the tendency of the variolous matter, than when in a more animalized state; therefore a vegetable and milk diet for a certain period, according to the habit of the patient, with gentle saline cathartics, will be a sufficient preparation, if continued a due time before inoculation is performed.

In the West Indies, this disease is more favourable among the negroes than the white inhabitants, and for the reasons we mentioned in a former chapter, viz. their way of living, which is almost wholly on vegetables. We have seen several in-

stances where white people and negroes were inoculated with the same matter, without any previous preparation to either; and in all such cases the white patients suffered much more than the black ones.

CH A P. XLII.

The Effect of Air in the Small Pox.

WHENEVER a putrescent tendency is prevalent in the body, the lungs are charged and oppressed to get quit of the load of phlogistic matter; but the facility of this discharge, as hath been mentioned, depends on the state of the air the patient breathes. The plague, for example, originates in warm and populous countries, where the atmosphere must be much impregnated. It is a well-known fact, that frost always gives a sudden check to the progress of this disease, which not only re-

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sults

results from cold being unfavourable to putrefaction, but also from the increased density and depuration of the atmosphere, by which, the discharge of the putrescent efflu-
vium from the body through the lungs is greatly increased.

The small pox, as well as other putrid diseases, is much regulated by the state of the atmosphere; a patient who is restless, pants, and is distressed to the last degree in a warm room, gets immediate relief upon being carried to a window, or out of doors, in a frosty day. The warm loaded air of a chamber which hath been respired, and consequently phlogisticated, is unable to give relief to the lungs when oppressed with an over proportion of phlogiston; whereas the cold dense and depurated air of the fields carries off a great charge by every expiration, and soon frees the lungs from the accumulated putrescent or phlogisticated matter.

It seems exceedingly probable, that by a due preparation before inoculation, so that the body may be the least possible disposed to putrefaction, together with gentle antiphlogistic purgatives after the operation, and a continued pure air, kept cool and frequently changed (particularly if its quality is improved by a mixture of dephlogisticated air) the disease may be made to pass off entirely by the lungs and intestines, without the eruption of a single pustule.

Although the air a patient respire cannot be too cold in this country, yet if the body is kept much cooler than common, the perspiration may be stopped, and a fever brought on totally unconnected with the small pox; this is to be guarded against by wearing the ordinary clothing both day and night, unless a sense of heat make some diminution necessary; for the great effect of cool air is in the respiration, and

not from its external contact with the body ; though something may also result from that, by making the discharge to the surface more difficult, and consequently sending off more of the variolous matter by the lungs.

Fires in the bed-rooms of patients in the small pox are improper, as they heat and rarify the air, which renders it less useful for respiration ; hence this disease is more fatal in hot climates, where the air is always more dilated and phlogisticated than in cold ones ; and it is even observed in the inland and leeward hot situations of the Sugar Islands, to be more severe and mortal, than on the sea-coast towards the wind, where the atmosphere is kept more cool and depurated by the sea air.

Baron Dimfdale says, ‘ Instead of sup-
 ‘ posing the fever in the small pox to be the
 ‘ instrument employed by nature to sub-
 ‘ due

‘ due and expel the variolous poison, we
 ‘ should rather consider it as her greatest
 ‘ enemy, which if not vigorously restrained,
 ‘ is apt to produce much danger; and that
 ‘ all such means should be used, as are most
 ‘ likely to controul its violence, and extin-
 ‘ guish the too great fervour of the blood.’

A fever seems to be an exertion of the
 system, produced by some irritating matter
 retained in the body; therefore to avoid the
 fever, the expulsion of this matter is neces-
 sary by that channel of evacuation which
 nature seems to point out. In the small pox
 this is most easily accomplished through the
 lungs, by the respiration of a cool de-
 purated air, and when the cause is thus eva-
 cuated, the fever will cease *.

* Dr. Ingen-housz has in his preface mentioned that his
 friend, the Abbe Fontana, had found an easy cheap method
 of procuring to a sick person the benefit of breathing any
 quantity of dephlogisticated air. For the method, see Dr.
 Ingen-housz's Preface.

PART III.

Of the Appearance, and Characters
of Nations, resulting from Climate.

CHAP. I.

The Object of this Third Part.

IN the First Part we have attempted to shew, that the state of vegetation in every country is determined by its climate; in the Second, we have considered how the qualities of food, with the external influence of climate, do actually determine the condition of animal bodies; from which it seems natural to conclude, that the mind, by its intimate connection with the body,

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will

will also be affected by its particular condition. The object, therefore, of the succeeding chapters, is to trace, and shew the actual influence of climate, in changing the powers of the mind, and to attempt the investigation of those particular causes, which produce these changes, and also to point out how the predominance of the same principle is productive of the same effects on the mind as well as on the body, in the extremes of heat and cold.

C H A P. II.

Of the different Opinions of the Causes which determine the Characters of Nations.

HELVETIUS, in his Essays on the Mind, treats the operation of physical causes, in producing the genius and characters of men, as groundless and chimerical.

merical. This gentleman refers all such differences to moral causes; and to enforce the justness of his principles, he attempts to prove, that all mankind are, by the hand of nature, equally fitted for all things; and that the characters of individuals, as well as those which are called national, result from government and education.

Mr. Hume, in his Essay on National Characters, takes the same side of the question, and endeavours to show, that moral causes are capable of forming different characters. This philosopher candidly acknowledges, that there is reason to think, that all the nations who live beyond the polar circles, or between the tropics, are inferior to the rest of the species, and are incapable of all the higher attainments of the human mind. This acknowledged difference he still endeavours to bring within the sphere of his principles, by supposing the poverty and
 misery

misery of the northern inhabitants, and the indolence of the southern, from their few necessaries, may, perhaps, he says, account for this remarkable difference, without having recourse to physical causes. A note annexed to the end of his First Volume of *Essays*, marked with the letter M, refers to the above paragraph, and evidently shews that, notwithstanding his willingness to attribute the differences among men to the influence of moral causes, he is obliged to admit of exceptions; and acknowledge that the negroes are naturally inferior to the inhabitants of the temperate zones.

In opposition to these authorities, we shall first mention Baron Montesquieu; this celebrated author has founded his spirit of laws on the influence of climate, and hath, with great judgment, in many instances, shewn how far the natural and moral
causes

causes may be made to assist or counteract each other.

Monfieur Du Bos has adopted the fame sentiments in his Critical Reflections on the Fine Arts. The ideas of this author are, perhaps, a little too far pushed, and his reasonings, in many places, somewhat too fine spun ; but notwithstanding this, there are, in many parts of his work, strong and evident proofs of the real influence of climate, in forming genius and character.

Dr. Fergufon, in his Effay on the History of Civil Society, confiders the temperate climates as the diftrict in which the human fpecies arrive at their greateft perfection, and fays, ‘ Under the extremes of heat and
 ‘ cold, the active rage of the human foul
 ‘ appears to be limited, and men are of inferior importance, either as friends or as
 ‘ enemies. In the one extreme, they are
 ‘ dull

‘ dull and slow, moderate in their desires,
 ‘ regular and pacific in their manner of
 ‘ life ; in the other, they are feverish in
 ‘ their passions, weak in their judgments,
 ‘ and addicted by temperament to animal
 ‘ pleasure ; in both, the heart is mercenary,
 ‘ and makes important concessions for child-
 ‘ ish bribes ; in both, the spirit is prepared
 ‘ for servitude ; in the one, it is subdued by
 ‘ the fear of the future ; in the other, it is
 ‘ not roused, even by its sense of the present.’

This author further adds, in another
 part of the same section, ‘ it is not in the
 ‘ extremes alone, that these varieties of ge-
 ‘ nius may be clearly distinguished. Their
 ‘ continual change keeps pace with the va-
 ‘ riations of climate with which we suppose
 ‘ them connected.’

Did we propose to draw any conclusions
 from authorities, numbers of others might
 be

be adduced ; but as that is not the case, further than to shew, that a difference is acknowledged by both parties, with respect to the inhabitants of the extreme climates, and that the fact seems disputed in the temperate ones only ; we shall attempt shewing how the moral or physical causes may prevail at different periods, in the same climate, if situated within the temperate zones.

CH A P. III.

An Attempt to reconcile these different Opinions.

IT is, we apprehend, admitted by all, that the characters of the Aborigines of the torrid and frigid zones are similar to each other, and different from those of the temperate climates. This variety, in those districts of the globe, cannot be supposed

posed to arise from the influence of moral causes. Were they the sources of difference, their necessary fluctuations must have produced, at various periods, nations, as well as individuals, possessing genius and character equal to those who very frequently appear within the temperate regions ; but as far as we can learn, hardly an instance of national greatness, and scarce a sample of superlative ability in individuals, in any line whatever, can be adduced to prove the possibility of their rising much above the low uniform level they have always been at*.

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* The famous Mahomet may be mentioned as an exception ; he was born about the end of the sixth century at Mecca, a town of Arabia Deserta, situated within the 22d degree of north latitude. This man had undoubtedly talents far superior to any of his countrymen, but the great ignorance of the Arabians, and the other nations adjoining, was the foundation of his success ; and although his mental powers appear conspicuous among his countrymen and followers, yet it is much to be questioned, if he would not sink very low, upon a just comparison with Ignatius Loyola, or any other enterprising European genius who had to combat with men of penetration. In a country where natural

causes

This continued sameness in the extremes of climate, must arise from sources powerful, constant, and equal; physical causes are therefore strongly indicated, as no moral ones, independent of natural and local qualities, can be supposed sufficiently powerful and permanent for the production of such unvaried consequences.

This reasoning seems to prove, that physical causes produce the peculiar dispositions of the extreme climates, and we shall endeavour to make it more evident hereafter by particularizing those causes: but in the mean time let us consider it as a fact established in the extremes only. From this it seems reasonable to suppose, that these natural causes will lose their influence

causes operate so powerfully as to produce a very general sameness of character, a small variety in favour of an individual becomes most conspicuous; but in countries less influenced by natural causes, genius often starts above the ordinary level, and to become a very distinguished character, an individual must rise still much superior to those who have risen above the multitude.

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by degrees as we recede from the torrid and frigid zones ; and in consequence of their diminution, the moral ones will gain strength.

It is obvious from history, that moral causes may be made to subdue the physical powers in the temperate climates ; but revolutions and external force often relax the attention of the legislature. Under such circumstances the physical influence must in time become prevalent, with greater or less rapidity, in proportion to the assistance or counter-action it meets with from the moral causes ; hence we suppose that nations in the temperate regions possessing the same district of territory, at distant periods of time, may widely differ from each other, by the prevalence of moral or physical influence.

The superiority of moral causes, we apprehend, never can take place in either the
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torrid

torrid or frigid zones, as the power of climate is in them too strong to be totally counteracted.

Man is an animal whose health must depend on the due execution of his bodily functions, which in him, as in others, are influenced by external causes. These are infinitely varied by climate; and however great the power of education and government may be over the actions of men in the middle climates, they must be allowed to have exceeding little in forming the complexion, size, and general turn of body; yet the inhabitants of particular countries are not less distinguishable by these external marks, than by their mental endowments; can we then suppose, that mind will be unaffected by the changes which the body undergoes? Although these changes are small among the nations of the temperate climates, when compared to those

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of the extremes, and may therefore be counteracted by moral causes, yet it appears highly probable, that without such counteraction, a particular turn of mind would regularly accompany each particular state of body.

From the above reflections it appears, that the doctrines of Helvetius and Mr. Hume may be in a great degree right, when applied to the temperate climates, and neither of these gentlemen seem to extend them further. Those who hope to solve every appearance and historical fact by natural causes only, without allowing any degree of weight to the moral ones, seem as erroneous as others who wish to exclude all physical sources of difference.

From the superior power of natural causes in the extreme climates, arise the sameness of ideas, and permanence of habit,

as the same regular causes must continue to produce the same uniform effects. The nations, as well as individuals of the temperate regions, are perpetually changing; and in the middle of this zone, where natural causes may be supposed to operate least, nations have rose to the greatest glory, and sunk to the opposite extreme; while those who live near to, or within the torrid and frigid latitudes, whether civilised or savage, feel the powerful influence of physical causes, by which they are fixed to a perpetual and limited sameness.

C H A P. IV.

*Some Reflections on what hath been said,
and what is intended in the succeeding
Chapters.*

ALL writers, travellers, and philosophers agree, that there is a real variety in the characters of nations; they

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differ

differ in opinion with respect to the causes of that variety only. In the preceding Chapters we have attempted to reconcile these opposite sentiments from two facts, which are allowed by both parties, viz. that of similarity in the inhabitants of the torrid and frigid zones ; and their inferiority to those of more temperate climates.

Although these facts are so generally allowed, yet no person (so far as we know) has attempted to trace the natural causes which produce this similarity of the human species in these opposite extremes of climate, and their inferiority in both, to the same species in the middle latitudes. Dr. Ferguson says, ‘ We are still unable to explain the manner in which climate may affect the temperament, or foster the genius of its inhabitants.’

Those writers who have taken the side of moral causes, have endeavoured to investigate

tigate the operation of these causes; but the advocates for the action of physical powers have been vague, unsystematic, and partial.

Baron Montesquieu's experiment with a sheep's tongue, and his reasonings on climate in consequence, are at best conjectural and general, and relate to heat and cold only as increasing or diminishing sensibility; were his proofs extended, they would lead us to believe, that the inhabitants of the arctic circle are more bold than those in the latitude of 50; but the contrary of this is a well-known fact.

In the Second Part of these Observations, we have endeavoured to shew how climate interferes with the health of the body, and prescriptions of the physician. Here it is proposed to extend the physical principles, which we have attempted to establish in the First and Second Parts, to mind as well

as body ; by which we hope to render it highly probable, that the similitude of the aborigines of the torrid and frigid zones results not only from natural causes, but from the prevalence of the same cause.

C H A P. V.

Of the Inhabitants of warm Climates.

BY the torrid zone, is meant that part of the globe which lies between the tropics ; but in the division of the earth which we at present adopt, the warm climates are extended to about the 30th degree north and south ; though the effects of a warm climate are no doubt decreasing from the latitude of the tropics, which are the limits of the sun's progress ; yet as the countries situated between them and the 30th degree have so great a proportion of his influence, we consider them as properly

perly falling within the title of this Chapter.

The Aborigines of the torrid zone, strictly speaking, may be divided into two kinds, viz. Indians and negroes.

On the north side of the equator, the first are a short squat people, with broad faces, thick lips, flat or flattish noses, long black hair, and skins more or less of a dark brown or yellow colour, varied by local causes; their countenances are dull, their bodies inactive, and their minds stupid and timid. The inhabitants of the Society and Friendly Islands who are situated within the 23d degree of southern latitude are fairer and taller than the tropical Indians of the northern hemisphere; their hair is also curled, and more resembling that of Europeans.

An insular situation must be favourable to this change, particularly when under

general cultivation, which is the case at Otaheite and the rest of these islands ; this not only keeps the air in a depurated state by allowing the sea winds to circulate freely over the land, but also supplies the inhabitants with a large proportion of vegetable food. These causes must greatly counteract a putrescent tendency, by which the colour of the skin will not only be improved, but the mental powers rendered more active.

In equal latitudes, the colds of the southern hemisphere are much greater than on the northern ; from which we may consider the inhabitants of the south on a footing, in point of climate, with those of the north, who are situated considerably nearer the pole*.

The

* In Chap. IX. of the First Part a conjecture is offered on the causes of cold in the southern hemisphere being superior to those of the northern ; it is there supposed, that the heat in any district of the globe will bear a certain proportion

The negroes are black, with very short curled woolly hair, with thicker lips and flatter noses than the Indians ; they are in general a taller and better-made people, and possess more spirit, and rather better understandings ; but are, however, like

tion to the quantity of phlogiston disengaged in that district. This now appears more probable, as by Dr. Crawford's Theory of Animal Heat, it has been shewn in the Second Part, that from atmospherical air absolute or latent heat is decomposed by the phlogiston evolved in the body, and discharged through the lungs, which heat becomes sensible by the decomposition. We apprehend the same decomposition will take place wherever the phlogiston in a disengaged state comes in contact with dephlogisticated air ; and hence we suppose, that on large tracts of land well clothed with vegetables, and stocked with animals, a greater proportion of phlogiston is continually impregnating the air than on small islands, and consequently changing a greater proportion of heat from a latent to a sensible state ; hence an insular situation is not only cooler than continents in the same latitude, by affording less phlogiston to promote the decomposition of heat, but is also more favourable to the discharge of this principle by the lungs. The rays of the sun, which are the sources of heat, generate or produce that heat in proportion to the perpendicularity of their direction, and that only when intercepted by bodies more or less opaque ; hence, as mentioned in a former Chapter, much of their heat, or power of generating heat, is lost in the seas which surround islands.

them,

them, lazy, dull in comprehension, fullen, and naturally timid, though in a less degree than Indians. Neither of these people have much hair on their bodies, and few of them, particularly the Indians, have much beard.

From the tropic of Capricorn towards the south, the aborigines of what is called South America, together with the inhabitants of New Holland, and those of the Cape of Good Hope, are the only people we know any thing of who fall within the limits fixed in this Chapter.

Those about Rio de Janeiro, and from thence to Rio Grande, situated from the 23d to the 30th degree south, are industrious and active, and a much bolder and hardier people than the inhabitants of Paraguay, who are within the southern tropic. The inhabitants of New Holland are said
to

to be a dark-coloured people. This may probably arise from being much intermixed with the negroes of New Guinea. As to their particular dispositions, little or nothing is known, though this vast country extends from the 10th to the 40th degree of south latitude.

The Cape of Good Hope, or Hottentot country, runs from near the tropic to the 33d degree south; and although its inhabitants are famous for their filth and want of improvement, yet they have naturally tolerably fair skins, and a considerable degree of industry and activity; they detest slavery, but serve the Dutch for wages; they breed sheep and cattle, and cultivate the soil. These are tasks to which the Aborigines between the tropics can never be brought but by force. In Africa, near the sea-coast, some individuals have made feeble efforts towards improvements, when stimulated

lated by the example of Europeans, with whom they have much intercourse in the way of trade.

When we come on the north side of the tropic of Cancer, the Indians are more hardy than those of the torrid zone, yet they are more slothful and timid than those further north. The inhabitants of Barbary are more active and bold than those between the tropics, yet they are much inferior to the nations further north, in ability both of body and mind. A part of Persia, the Mogul Empire, and a considerable proportion of China, are situated between the tropic and the 30th degree ; these countries are famous for the soft timid turn of their inhabitants ; and although some parts of them are much civilized, yet they do not possess that strength either of body or mind, which hath always distinguished the inhabitants of the more northern climates.

The

The Arabians are said to be a brave people. This character may, in some degree, be accounted for, from the dry and barren, but healthful soil of Arabia Petræa, and Arabia Deserta; which, together with the custom of robbing, and being from infancy exposed to danger, cannot fail to give them great advantages over their indolent neighbours. The people of Arabia Felix possess much less of this disposition; they sink under the influence of a vertical sun, and remain secured from foreign attacks, by the ocean on three sides, while the avenues to their country by land is guarded with deserts, and their more active northern tribes, who extend themselves over the Isthmus of Suez and round the head of the Mediterranean sea, as far as the 31st or 32d degree of north latitude.

C H A P. VI.

Of the Inhabitants of the Frigid Zone.

TH E natives of this district of the globe are a short, thick, squat people, with straight black hair on their heads, and very little on their bodies, having exceeding little beard in advanced age ; their noses are flat, their lips thick, and their skins dark brown ; in short, they are in every respect similar both in body and mind to the native Indians of the torrid zone, though rather less in stature * ; they are equally lazy, stupid, and timid. Such are the Samojedes, Groenlanders, and Zemblians, and all who inhabit to the north of the arctic circle ; but even eight or ten degrees, or more, south of this line, these effects of climate are in some places discoverable, either on the bodies

* This difference results from the extreme rigidity produced by the excessive cold.

or in the minds of the inhabitants, which increase as we move north until they arrive at the strong marks above mentioned.

C H A P. VII.

Of the Inhabitants of the temperate Climates.

WE suppose the temperate climates to extend from the latitude of 30 to 65. The inhabitants of these two districts, one on the northern, and the other on the southern hemisphere, are superior to the nations of either the torrid or frigid zones, in form, complexion, temper, and vigour both of body and mind. On the south side of the globe, there are no nations between the above latitudes, whom we are acquainted with, except the inhabitants of New Zealand, and some scattered tribes of
Indians

Indians about the Terra Magellanica, and Terra del Fuego *. The New Zealanders are a well made, hardy, bold people †; and although little is known of the Magellanic inhabitants, yet there is enough to prove, that climate hath also its due effect there, as these Indians are much bolder and more warlike than those of the tropical latitudes, or even those who inhabit so far south as the river La Plata, where they are neither without vivacity, nor a certain degree of spirit ‡; yet they have all submitted to the Spanish yoke; while those further south still keep their independence, and were even formidable, and helped to extirpate a co-

* The climate of the island of Terra del Fuego and the Straits, is so exceedingly severe, though far within the temperate zone, that its inhabitants resemble more the Aborigines of the arctic circle, than those of a more temperate region.

† See Capt. Cook's Voyages.

‡ See Sir Francis Drake's Voyages.

lony

lony from Old Spain, fettled in the Straits of Magellan *.

When we come into the northern hemisphere, we find all the nations of Europe, both antient and modern, who ever have made, or do now make, any figure in the world, situated between the latitudes of 30 and 65; to particularise them would be too historical for this place.

When we go into Asia, there the same thing is evident; a part of China extends beyond the 40th degree, and from this northern part does the military strength of that empire arise.

The Tartars, who run much further north, are a bold and hardy people; but such of them as have removed into China,

* See Sir Thomas Cavendish's Voyage round the World.

since the conquest of that empire, yield to the influence of its climate.

In America, the aborigines from the 30th to the 65th degree are a bold people, and much better made than those of either the torrid or frigid zones, nor are they naturally wanting in mental qualities; yet it is even remarkable on this continent, that the Indians of Florida and Georgia at the southern extremity, and those about Hudson's Bay at the northern, are less warlike, and in every respect inferior to those situated between them.

C H A P. VIII.

*The Effects of a putrescent Tendency in
the human Body.*

THAT the purity or phlogisticated state of the atmosphere we breathe, hath the greatest effect on our bodies when in health, as well as when afflicted with disease, must, we suppose, appear evident from the Second Part of these Observations. That the warmth of climate is productive of this impregnated state of the atmosphere, we apprehend cannot be doubted; for these reasons, and what shall hereafter be offered, we conclude, that the particular differences between the inhabitants of the torrid zone and those of the temperate climates, both in form of body and turn of mind, result from an habitual putrescent tendency with which their constitutions are loaded.

In the torrid zone the heat of the climate, and impregnated state of the atmosphere, give animal bodies a strong propensity to putrefaction, by which a more copious evolution of the phlogistic principle takes place. In the frigid zone we find the same prevalent tendency to putrefaction in a still higher degree, resulting from want of perspiration and a continued animal diet; and to this greater excess of putrescency from food and cold conjoined, we impute the diminished size and flat disagreeable countenances of these northern nations.

Putrefaction, in living animal bodies, is much increased in the hot latitudes by the impregnated state of the atmosphere, as in these countries the air is unable to free the body by the lungs from the putrescent matter which is continually disengaged; it therefore accumulates in a certain degree through the whole system, and goes off by
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the skin more copiously than in colder climates, to which the colour of the body may probably be attributed, and also its particular form, and that peculiar disposition of mind, which marks the natives of the tropical climates.

In the frigid zone the air is exceedingly favourable to the discharge by the lungs, as it is there dry and unimpregnated*, but the aliment of the inhabitants is animal, and mostly fish. A diet of this kind co-operates with the want of perspiration to bring on a general and strong putrescent tendency; therefore from these opposite external causes, viz. heat and cold, we find the same effects, for the internal heat of the human body is nearly the same in all climates.

The effects from these causes are in every respect so exactly similar, as to leave no

* See Chap. XXVII. of the Second Part.

doubt of their resulting from the same state of body, however different the means of producing that state originally were ; as it must be remembered, that the same degree of putrescency, induced by any cause whatever, is exactly productive of the same effects on both body and mind, whether from heat, cold, damp, food, or extreme relaxation.

A putrescent tendency is the only point in which the inhabitants of the torrid and frigid zones are necessarily alike from circumstances of climate, and this cause alone seems capable of regulating their external appearance, as well as mental faculties.

The inhabitants of the middle climates breathe an air, which, though not so much dephlogisticated as that of the frigid zone, yet is vastly more so than the air of the warm latitudes ; added to which, their perspiration

piration is, generally speaking, sufficiently plentiful, and the principal part of their food is vegetable.

From these united causes arise the less habitual putrescent tendency of the inhabitants of the middle climates, by which a much less proportion of phlogiston is discharged through the skin; and in consequence the colour and appearances of body, and faculties of mind, of the nations of the middle regions, are as widely different from those of the torrid and frigid zones, as the climates which produce and nourish them.

C H A P. IX.

A putrescent Tendency from Disease gives the same Appearances and Turn of Mind which are natural to the Inhabitants of the Torrid and Frigid Zones.

THE scurvy is a general putrescent tendency of the body. Those who begin to be afflicted with this disease become of a pale wan colour, and of a dull, inactive, melancholy disposition. When the disease increases, it is with difficulty they can be made to perform the smallest exertions ; the skin becomes darker, and the reluctance to motion increases in proportion to the progress of the putrescent tendency.

Consumptions are also from a putrescent cause. Dulness, oppression, and even melancholy, are symptoms of this malady. When
the

the tendency is diffused through the whole body, the skin is generally pale, and often swarthy, accompanied with great dislike to exercise. Putrid fevers do in the same manner darken the skin, and give the same dull, inactive turn of mind.

By thus finding that all causes which induce a general putrescent tendency in the body, do produce the same appearances and effects in proportion to their degree, which result from the extremes of climates and animal food, we are thereby led to consider the above reasoning strongly confirmed.

CH A P. X.

Some Reflections respecting the Cause of Swarthiness in the Savages of the Middle Climates.

TH E food of these uncivilized nations is mostly animal, the effect of which is much increased by the damp impregnated atmosphere of the woody countries they inhabit. This state of the air prevents a free discharge both by the lungs and skin. The diminution of these discharges must give a putrescent tendency ; and if we add the continual exposure of body to all the vicissitudes of season and inclemencies of weather, we shall find, that though the understandings of these people are quicker, and their bodies better shaped and stronger, with minds more firm and
hardy,

hardy, than those of either the torrid or frigid zones ; yet the natural causes which exist in woody countries, together with their manner of living, are sufficient to make a wide difference between them and the civilized nations of the same latitudes, whose food by the cultivation of soil is different, and whose bodies are clothed and protected from the rigour of the seasons ; which in fact is, in some degree, altering the climate, by having and using these means which subdue its too violent effects.

C H A P. XI.

*Why Negroes possess more Activity than
Indians of the Torrid Zone.*

IN the First Chapter of this Part, it is observed that negroes have a degree of spirit and appearance superior to the Indians
of

of the torrid zone, and this superiority has always manifested itself when contests have happened between them*. The cause from which this difference originates seems difficult to investigate; the following conjecture, founded on the facts we are about to mention, afford a probable solution.

In the formation of negroes, there seems to be an original peculiarity in the reticular covering of the body immediately under the epidermis, called Rete Mucosum; it gives the black colour to the skin, and when by scalding or burning this substance is destroyed, the new skin becomes white. The hair of the human body hath a bulbous

* Many instances might be given of this in the Dutch settlements of Surinam, Isaac Cape, &c. on the American continent, but the following is one in our own colonies :

On the coast of St. Vincent, about fifty or sixty years ago, an African ship was wrecked; the negroes soon got the better of the brown Indians or aborigines, and have in a manner extirpated them, and remain in possession of their country.

root,

root, which must draw part of its nourishment from this reticular covering; and as that of negroes is so very different from the rest of mankind, it may be supposed to derive its peculiarities from this source of its growth. Instances are not wanting of negroes born either without this reticular substance, or with it very transparent. Such are in the West-Indies called improperly white negroes; their skins are of a cadaverous pale colour, and eyes too tender to bear the light of day; they are generally delicate, stupid, and unfit for service; their hair is also of a whitish colour, and neither so hard nor short as that of blacks.

These may be considered as *lusi naturæ*, for they are manifestly different from their parents; and the want of the black colour in the rete mucosum (or rather of these properties, whether in construction or otherwise, which give the black colour) seems to be

be attended with the consequences above mentioned, viz. delicacy, stupidity, and unfitness for action.

The perspiration of negroes is of a strong pungent alkaline odour, which seems to arise from some peculiar property or power in the reticular covering which gives colour to the skin. This extraordinary phlogificated perspiration, so remarkable in blacks, we suppose, depends on the powers of secretion in the rete mucosum, by which the putrescent matter is more copiously discharged from the surface of the body; and undoubtedly a more free discharge of the putrescent effluvium by the skin, may not only liberate the constitution in a certain degree, but tend to produce that very blackness in the rete mucosum itself.

From these very distinguishing external marks, negroes seem a peculiar variety of
the

the human species, better fitted by nature than those of fair complexions to discharge by the pores of the skin the phlogiston evolved from their bodies, and consequently are much better adapted to the warm climates. If blackness of skin were acquirable, like that of brown, by a long continued habitual putrescency, the inhabitants of Groenland and Nova Zembla should be black, and their hair short and curled, as they are more in this state than the aborigines of hot climates; yet the colour of their skin is only dark brown, and does not affect the growth of their hair, which is long, straight, and black.

Sir John Pringle, in his experiments on blood, found that the crassamentum after allowed to become putrid, being mixed with water, gave it, as he himself expresses it, a tawny hue. This is in favour of our opinion relative to the colour of Indians.

These

These people, both in the torrid and frigid zones, as well as the savages of the temperate latitudes, appear the same with the inhabitants of the middle climates, and only changed by the causes we have mentioned ; and it is probable, that a removal to the middle latitudes would, in a few generations, bring them to a better colour, form, and understanding.

C H A P. XII.

The Effect of clearing woody damp Countries.

THE air of all woody countries, particularly if flat, is more damp and phlogisticated than the air of the same country is when cleared of its woods. In the First Part we have considered vegetation as depurating phlogisticated air, and
rendering

rendering it fit for animal respiration ; it may therefore seem contradictory to say, that the air of woody countries is always more phlogisticated than the air of the same country would be, were it cleared of its woods.

There is no doubt that short vegetables and scattered trees, through which the rays of the sun penetrate, and the air circulates freely, must tend to purify the atmosphere, and make it more serviceable to animal life ; but we must consider that the countries now alluded to are covered with a close woody coat, through which the rays of the sun never penetrate to the surface of the earth ; and consequently that the power of these trees, in purifying the atmosphere, is confined to their tops, on which only the rays of light can act, while the air retained under them is little agitated, and seldom changed, and is continually receiving fresh

T impregnations

impregnations from decaying trees and rotting leaves which daily fall to the ground; and were it not for the great depuration of the air which takes place in the upper parts of the trees, by which its gravity is increased, and therefore must be continually falling towards the earth, while the impregnated air is constantly ascending, close woody countries would, we apprehend, be unfit for the purposes of respiration.

The continent of North America is vastly extensive and flat; it was totally covered with woods, and interspersed with lakes, rivers, and morasses, all of which contributed to keep the air in a stagnated, damp, and high impregnated state.

Lightning, even a great way north, was then most frequent and general, which shewed its atmosphere to be highly charged with phlogiston.

When

When we consider in how great a degree these causes existed before cultivation made any progress on that continent, we may discern sufficient grounds, upon our principles, for both the colour and turn of mind of the Aborigines of that vast country.

At this time the surface being much cleared, lightning has become less frequent, the air is more pure, dry, and dephlogisticated ; vegetation is also become less luxuriant in these cleared parts of the country, which is, we apprehend, as much the effect of a depurated and changed atmosphere, as of exhausted soil. Putrid diseases are, in consequence of these alterations, less frequent, rapid, and dangerous than formerly.

The European inhabitants who were transplanted to that continent, seemed for a time to degenerate ; but the face of the country, being by degrees changed from woods and

morasses to a clear surface and cultivated fields, and consequently from an impregnated to a pure atmosphere. Those appearances have subsided, and the natural effects have begun to flow from these changes, which there was every reason to expect from its cultivation and climate; and the more quickly it is deprived of its woody covering, the more rapid will its improvements be in every thing that hath distinguished the European nations in equal latitudes.

CHAP. XIII.

That Slavery appears necessary to the Agriculture of very hot and very cold Climates.

FROM the natural effects of climate in the torrid zone, we have seen that the inhabitants were, to the last degree, slothful, and had they never been visited by Europeans, they would have, probably to
this

this day, remained in their original indolence. The great Baron Montesquieu, in his Spirit of Laws, says, the more the physical causes make mankind inactive, the more should the moral ones be calculated to counteract them. This rule seems exceedingly just; and we shall concur with him still more strongly, when we find, from experience, that example will not produce the exertions in these climates, which are necessary for agriculture, society, and civilization.

The island of Tobago was depopulated, after being far advanced in its cultivation by the Dutch; yet neither the native Indians who remained on the island, nor those more numerous tribes on the island of Trinidad, who daily visited it, ever thought of following the example of the industrious expelled inhabitants, or of even making any advantage of the improvements they

left behind ; their buildings fell to pieces, and the surface was soon again covered with woods.

The free negroes*, or black Indians, as they are called, as well as the real brown Indians, or Aborigines of the island of St. Vincent, lived on friendly terms for a great number of years, before the close of last war, with the few French who were settled there ; yet they never attempted the smallest improvement, in imitation of those which were daily carrying on in their view by the French.

These, and many other instances of a like kind may be given to shew, that in very warm climates, the strongest stimuli to the human mind are incapable of produc-

* These people were brought from Africa about fifty odd years ago, by a ship which was wrecked on the island of St. Vincent.

ing mental activity, and that nothing under absolute necessity will force to bodily exertion *.

Slavery, and the authority resulting from it, seem therefore in a certain degree necessary to counteract the natural causes of inactivity in the hot latitudes. If liberty there was universal, it would be so far from producing those good effects which some ingenious writers on society and jurisprudence have imagined, that the most op-

* Many quotations might be brought from the Spirit of Laws, which bear strong relation to this subject, but we shall content ourselves with the following :

‘ La chaleur du climat peut être si excessive que le corps
 ‘ y fera absolument sans force. Pour lors l’abattement pas-
 ‘ sera à l’esprit même ; aucune curiosité, aucune noble en-
 ‘ treprise, aucune sentiment généreux ; les inclinations y
 ‘ seront toutes passives, la paresse y fera le bonheur ; la
 ‘ plupart de chatimens y seront moins difficiles à soutenir,
 ‘ que l’action de l’ame, & la servitude moins insupportable,
 ‘ que la force d’esprit qui est nécessaire pour se conduire
 ‘ soi-même.’

De l’Esprit des Loix, tome ii. chapitre 2.

posite consequences would take place ; the inhabitants would sink into sloth, and the surface would soon again become clothed with spontaneous productions ; no further exertions would be made than what were necessary to answer the urgent demands of nature ; and thus, by attempting to establish customs and laws, which too much coincide with the natural tendency of climate, we should add to its influence, and produce consequences diametrically opposite to those proposed.

In the course of the foregoing Chapters, we have endeavoured to make it appear, that the same effects on both body and mind result from exceeding cold climates, which arise from very hot ones ; the natural causes therefore in those latitudes, should also be counteracted by the moral ones.

In

In Poland, Russia, Hungary, &c. the climates are sufficiently cold, to produce in a certain degree the prevalent disposition of the frigid zone ; and consequently, the peasantry of these northern kingdoms are subject to the scurvy, stupid, void of curiosity, and slothful almost to the last degree. Here that authority which results from slavery becomes as necessary as in the torrid zone, and did it not actually take place, the soil would in a great measure be neglected ; and although their inactivity could not be so excessive as those people who inhabit beyond the arctic circle, yet it might be sufficient, were they in a state of absolute freedom, almost totally to obstruct the progress of agriculture, civilization, and refinement.

The people of superior rank in those nations, from a different mode of living, good and warm clothing, and due protection
from

from the rigours of their climate*, are possessed of that activity of mind, which is necessary to gain superiority over the inferior ranks. The taste which they acquire from more enlarged understandings, and the example of more southern nations, all concur to make them exert that authority over their dependents, which is necessary to produce the requisite exertions on their parts; hence it seems demonstrable from the action of natural causes, that slavery is in a certain degree as necessary to the improvement of some countries, as liberty is to that of others.

* Warm clothes and stoves are the luxuries of Russia, as well as the necessary precautions to prevent a too great suppression of perspiration. When a peasant comes from many hundred miles distance to Petersburg, instead of going about the streets to satisfy his curiosity, he goes to enjoy himself in one of these stoves or hot-beds, and does not discover the least surprise, or wish to be better acquainted with the particulars of any thing in the capital.

Amongst

Amongst the inhabitants to the north of the arctic circle, who live in a savage state, nothing of this kind is necessary, as they have little labour to perform, and their powers being more cramped by the influence of food and climate, which act so generally alike on all, that none are fitted to make such superior exertions, as can enable them to acquire and support any degree of power, further than that which arises from bodily strength ; and from this superiority alone seems to result the slavery of women among all savage nations ; the extreme insensibility of these people, and abhorrence of exertion, from the causes we have mentioned, make the men the tyrants of their families, by inflicting the whole labour on those over whom they have power ; and this degree of superiority seems as necessary to make the women perform the drudgery of their station, as the power of masters over their slaves, in the civilized parts

parts of very hot or very cold countries.

By the writers we have alluded to, it is generally alleged that no people will work with satisfaction but such as are to enjoy the immediate and entire benefit of their own labours.

This allegation seems plausible, and to every mind possessed of a certain degree of knowledge and activity, is perfectly conclusive when applied to itself; but it must be observed, that to give it general weight, we presuppose a degree of mental sensibility, which does not generally exist in the human race; and without that certain degree of it, which is not to be met with in the Aborigines of either the torrid or frigid zones, these arguments fall to the ground.

Whether the conduct of the inhabitants of the temperate climates, in forcing those
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of the torrid zone from their natural indolence and stupor into a state of greater activity, or whether those of superior ranks in the northern kingdoms who do the same, are culpable or not, we leave to be determined by others ; but it appears to us, if cultivation and improvements are to be prosecuted in these climates, slavery, to a certain degree, is indispensably necessary. This is confirmed by observing, that the improvements on the coast of Africa were made by slaves ; and little as they are, it is probable that nothing would have been done, had slavery not existed among the natives. From the voyages of Capt. Cook, slavery exists in the Friendly and Society Islands, which are situated between the 15th to the 23d degrees of south latitude, to this circumstance they seem to owe their cultivation ; as no improvements are to be found in the tropical latitudes, where the superiority resulting from slavery does not take place.

C H A P.

C H A P. XIV.

The temperate Regions proper for Freedom.

ALTHOUGH we have extended the temperate climates from the 30th to the 65th degree only, yet (as hath been observed in a former Chapter) these causes which exist in their full force to the north of the arctic circle, may be found to a certain extent, in different places as far as eight, or even ten degrees south of that circle, or perhaps, from particular local circumstances, even still further*; but it is undoubted, that in the middle climates, among civilized nations, none of these effects are produced by either food or air, which we have pointed out, as the causes of form, colour, and disposition in the

* The miserable inhabitants of the Terra del Fuego are an example of this sort.

two extremes ; the body is therefore at all times in a less putrescent state, and consequently more active and vigorous, and the mind, from the same cause, becomes more quick to comprehend, and more bold to execute ; slavery therefore is not only not necessary in the temperate climates to force exertions, but the very idea is generally held in abhorrence ; and although from revolutions a temporary slavery may take place in any country, yet its duration cannot be long where climate does not concur to soften and stupify the intellectual powers.

The natural activity of body and mind, which the inhabitants of the middle districts of the globe possess, renders them sufficiently sensible of every stimulus to action ; and in particular countries where a pure air is assisted by a due degree of perspiration and proper food, the inhabitants are sometimes too susceptible of impressions, and

over-prompt to action; while in others, from a more flat, moist surface, consequently a more humid impregnated atmosphere, and less perspiration, the inhabitants are less active in body, and less quick in comprehending and executing.

There are a great variety of characters amongst the different nations in the temperate regions, and even many subdivisions in different parts of the same nation; but we shall not attempt descending into these particulars, as it is supposed the general principles laid down will apply when duly examined and estimated, and proper allowances made for the alterations on the surfaces of countries at different periods, and the concurrence or counteraction of moral causes in each period and place.

T H E E N D.





